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Will Hawaii Stay in the Race?

The pulse beat of Hawaii is measured by the price of sugar. Today the price of sugar is high, and despite the increased cost of production, the labor situation, and other obstacles that place Utopia beyond our grasp, generally speaking, the status of the industry is sound. Some day the price of sugar will be low—there are millions of acres of tropical land suited to the cultivation of sugar cane. Some of this will inevitably be developed, the industry will grow, competition will be keener.

Shall we make certain of a margin of profit under less favorable circumstances?

Shall we refuse to be content with our present leadership among the cane-growing countries of the world and devote ourselves to a still higher development of our agriculture?

Shall we advance to an efficiency in agriculture comparable with that already attained by certain industrial concerns of the eastern states?

Shall we, as Secretary Redfield urged in addressing the Reconstruction Congress at Atlantic City in December, "concentrate thought, purpose and effort on output—find and seize hold upon all science has said or can say concerning industry"?

It would seem if Hawaii is to stay in the race that these are the things which she must do.

Sugar Cane Beetle Borer Parasite in Queensland.

In 1910 when Muir and Kershaw were working in Queensland on the sugar cane beetle borer parasite (*Ceramasia sphenopheri*), they reported that they had established it in the Mossman district, Queensland, where their field cages were situated. Subsequently it was reported that it had disappeared from that locality, that it had died out. This appears not to have been the case for Dr. J. Illingworth has found it in that locality and has taken colonies from there to other parts of Queensland where the borer beetle is abundant. The fact that it has been able to maintain itself for eight years in the Mossman district indicates that with proper handling it is likely to become established in many other parts of Queensland.

F. M.

CANE BY-PRODUCTS IN NATAL.*

A comparatively new South African enterprise is represented in the manufacture of rectified alcohol, methylated spirit, ether, and cane-wax by a cane by-products company at Merebank, in Natal. The original venture was the extraction of wax from the refuse of the sugar mills. This product is termed mila and in appearance is like rubble. Mila is dried on the sugar estates and then sent to Merebank where it is put in an extractor which is constructed in two sections, the upper part of which has a false perforated bottom. At the top is a condenser and a benzine tank combined, and, after being subjected to a certain process, the wax and benzine pass through a side-glass into the bottom chamber. Here the benzine is driven from the wax and the latter put into moulds. The company lately, according to the Board of Trade Journal, has undertaken to manufacture "natalite" (or motor spirit) which it is claimed will in time displace petrol for driving machinery and particularly motors. The source of natalite is molasses from the sugar estates, which is brought to Merebank and drained into 250,000 gallon tanks. The molasses is then run into large vats and fermented. Next it is pumped up into a receiver and the wash run into a still. The spirit is

* Jour, Indus. & Eng. Chem., September, 1918.

separated by a heater from the wash which is used for fertilizing purposes. The vapor of the spirit passes through two columns and a still in which the good spirit is separated from the best of 70 overproof. The best is used for the preparation of natalite, the weaker making methylated spirit.

[R. S. N.]

ADDITIONAL EXPERIMENT STATION WORK PROPOSED AT ANNUAL MEETING.

There were several suggestions at the Annual meeting proposing additional lines of investigation on the part of this Experiment Station. Various committee reports, cited as follows, advanced ideas on the subject:

THE ECONOMY AND EFFICIENCY OF LABOR.

James Gibb, Chairman, Committee on Cultivation, Fertilization, and Irrigation on Irrigated Plantations: "The men recently inducted into the Army from here would have been of mighty little use in heading off an enemy when they first joined up, but these same men, after they are properly trained, would accomplish a vast deal more just because of that training. The same is true in every other line of action. Might we not confine our experiments for the present to see how much can be done with the small supply of labor that is left us? Consider how much more work is accomplished by the men working by contract as compared with those working for day wages. Might be not be able to contract still further? The present shortage of labor makes it imperative to focus our minds to this phase of the subject. It might be a good idea to have the services of as many of the Experiment Station staff who could be spared to study economy of manual labor on the plantations, and discontinue starting any further experiments of a nature that would take away labor from absolute necessities in caring for the crops. This is a branch of the business that the Station has never been called on for their assistance. If only one or two men were to go round and report through the *Planters' Record* any labor-saving device that they may stumble on to, or think of them-

selves, it might lead to others adopting them, and, on the whole, be a big saving in manual labor, just as there has been a great saving of sugar in late years by improving milling through similar tactics. The plain, ordinary man has been doing wonders lately and is likely to beat the professional experts in warfare at their own game. Though the man in the cane field has not been consulted much in the past, yet a consensus of opinion from that source might do much to improve our methods."

CULTIVATION EXPERIMENTS AND GREEN MANURING.

John Ross, Chairman, Committee on Cultivation and Fertilization on Unirrigated Plantations: "The Paauhau experiment of no-animal cultivation versus animal cultivation, controlling the weeds by hand and spraying, is one that the H. S. P. A. Station should try out more extensively in the Hilo district, especially in a wet season like our past one, in which there have been only twenty-three days since February 26 till August 26 that spraying for weed control could be practised. But the more important point to demonstrate would be as to whether or not the soils of the Hilo district (which are entirely different in texture from Olaa or Paauhau) will continue to yield successively without the intensive animal cultivation that has been practised in the past.

"If it could be proven that even off-barring could be eliminated from successive ratoons without loss of yield, it would be a big item in labor and costs."

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"Owing to the assured labor shortage, cane areas will inevitably have to be reduced proportionately to the percentage of labor lost. It would be well, therefore, to lay out to green soiling all such areas as we may be compelled to abandon to cane, in an effort to help out the fertilizer situation. And it behooves the H. S. P. A. Station to find for the Hilo district, if possible, some legume that can be raised successfully without the help of commercial fertilizer or other stimulant."

THE VALUE OF PRESS CAKE.

Horace Johnson, Chairman, Committee on Manufacture of Sugar and Utilization of By-products. After quoting various estimations dealing with the monetary value of press cake, Mr. Johnson adds: "We have an estimated value of from $5 to $20 per ton, the average being $10 per ton. You will note that there is a general opinion in favor of field tests being made to deter-

mine its comparative value as a fertilizer. Such tests should be carried out through an extended period in order to obtain the lasting effects of mud-press fertilization."

FURTHER OBSERVATIONS ON THE USE OF IRRIGATION WATER IN HAWAII.

By R. M. Allen.

INTRODUCTION.

The purpose of this article is to assemble some of the data that have been collected from irrigation experiments and soil moisture determinations at the Waipio substation, and to point out the general tendencies of the results, in an effort to render them of some practical value to the irrigator.

In considering these figures, it should be borne in mind that they are the outcome of work only on the particular type of soil, a medium clay loam, found at Waipio, and although the general tendencies are undoubtedly the same, regardless of the soil types, the figures, especially those pertaining to soil moisture percentages, are hardly applicable under radically different soil conditions.

Figures on the amounts of water are the results of measurements made at the edge of the field, or at the point of delivery, termed "net duty," as distinguished from "gross duty," based on the flow of water from the source. In other words, the quantity of water reported is that actually applied to the cane, exclusive of seepage and other transmission losses. An attempt will be made here to explain more fully the statement made in the Record, Vol. XVIII, page 303: "The true value of an irrigation is measured not by the amount of water that is applied to the soil, but by the amount of moisture that is retained by the soil, and the manner in which it is distributed throughout the soil area, both laterally and perpendicularly."

EFFECT OF VARIED AMOUNTS OF IRRIGATION WATER ON CANE YIELDS.

An experiment was harvested at the Waipio Substation last year, to which irrigation water had been applied in varied measured amounts. It was originally intended that this experiment should run for two years, and the water was applied so that at the end of that time the plots B, C and D would have received 2,000,000, 6,000,000 and 10,000,000 gallons per acre respectively. As it was necessary to harvest the experiment sooner than had been planned, the total amounts of water were less than the original plan, although in the same proportion. The water, as applied, is given in the following table:

TABLE NO. I.

Plot	Total Water Applied per Acre	
	Acre feet *	Gallons
B	2.45	800,000
C	5.59	1,920,000
D	8.79	2,860,000

The above water was applied in fifteen day intervals; great care was taken to prevent any water being lost by surface run off and the experiment was irrigated by the same man throughout the season, thus eliminating the personal factor always present in an irrigation study. Measurements were made by means of a two foot Cippoletti weir installed about 500 feet from the experiment field. During each irrigation, a flow of .431 cubic feet per second, or a "man's water" of 116,000 gallons per day of ten hours was maintained, and the stated amounts of water were obtained by applying this flow to the various plots as follows:

TABLE II.

Application of water per Irrigation and required time of flow.

Plot	Water applied per irrigation			Time of flow per line (Minutes)
	Ac. ft. per acre	Inches per acre	Gallons per acre	
B	:156	1.87	50,832	1
C	.470	5.64	153,150	3
D	.790	9.48	257,422	5

* An "acre foot" is the amount of water that will cover one acre to a depth of 1 foot, or 325,850 gallons.

The results of the treatments described above are as follows:

TABLE III.

Effects of varied amounts of irrigation water.

Plot	Total water applied per acre		Cane yield tons per acre	Lbs. cane per 1000 lbs. water	Gallons water per ton cane	Lbs water per lb. cane
	Acre feet	Gallons				
B......	2.45	800,000	56.60	156	1,410	53.5
C......	5.59	1,920,000	57.48	58	3,340	144.0
D......	8.79	2,860,000	57.46	40	5,000	208.7

Juice samples from this experiment were somewhat unsatisfactory and although the sugar yields, based on these, are in accordance with the above results they are not considered reliable, hence only the cane yields are reported here.

It is interesting to note the uniformity of the yields under the three widely different amounts of water, and although there is somewhat of a question as to the applicability of these results on a large scale, it is believed that the explanation, from the soil moisture standpoint, that follows will show that the general tendency of the results are reliable.

SOIL MOISTURE STUDIES UNDER VARIED IRRIGATED CONDITIONS.

Throughout the season soil samples were taken in this field one day before irrigation and two or three days after irrigation, with the object of tracing the depth of penetration, or percolation, of the known amounts of water, and to determine the percentage of the applied water that remained in the zone of plant growth. The average weight of this soil is 71.89 lbs. per cubic foot, a figure which is used in making calculations in this article. The average maximum water retaining capacity of the soil under field conditions is about 41%, and the optimum from 30% to 32%. Using the above mentioned figure as the weight of a cubic foot of soil, the conversion from percent moisture to acre inches per acre foot of soil is made as follows: 13.64 x % moisture. The figures presented here are averaged from 1,620 moisture samples. Briefly summarized the amount of water retained per irrigation is as follows:

TABLE IV.

Acre inches of water retained per 6 feet of soil for various quantities of water applied.

Inches of water	Inches of water
Applied	Rtained — 6 feet of soil
1.84	2.14
5.64	3.19
9.48	4.35

Expressed in terms of total water applied and total water retained, including the rainfall that occurred between the before and after irrigation samples, the results appear as follows:

TABLE V.

Relation between total water applied and total water retained in upper six feet of soil.

Plot	Water applied (inches)			Water retained in upper 6′ of soil	
	Irrigation	Rainfall	Total	Acre inches	Per cent
B..............	16.56	3.26	19.82	19.28	97.27
C..............	50.76	3.26	54.02	28.71	53.14
D..............	85.32	3.26	88.58	31.12	35.13

TABLE VI.

Typical set of samples, showing depth of penetration of Irrigation water.

Depth of sampling in feet	Per cent moisture		Increase due to irrigation	
	Before Irrig.	After Irrig.	Per cent	Acre Inches
0.5	24.36	31.88	7.52	1.03
1.5	27.54	31.86	4.32	0.59
2.5	28.67	30.47	1.80	0.24
3.5	28.81	30.22	1.41	0.19
4.5	29.71	30.32	0.61	0.08
5.5	29.94	30.44	0.50	0.07
Average and Total	28.17	30.87	16.16	2.20

Depth of Irrigation = 5.64 Acre Inches.

Depth of sampling in feet	Per cent moisture		Increase due to irrigation	
	Before Irrig.	After Irrig.	Per cent	Acre Inches
0.5	25.66	33.55	7.89	1.08
1.5	27.79	32.70	4.91	0.67
2.5	28.37	31.49	3.12	0.43
3.5	29.58	31.48	1.90	0.25
4.5	29.88	32.80	2.92	0.40
5.5	30.19	33.92	3.73	0.51
Average and Total	28.58	32.66	24.47	3.34

Depth of Irrigation = 9.48 Acre Inches.

Depth of sampling in feet	Per cent moisture		Increase due to irrigation	
	Before Irrig.	After Irrig.	Per cent	Acre Inches
0.5	24.64	34.20	9.56	1.30
1.5	28.02	33.44	5.42	0.74
2.5	28.89	32.36	3.47	0.47
3.5	29.52	32.80	3.28	0.45
4.5	30.15	33.55	3.40	0.46
5.5	30.12	34.53	4.41	0.60
Average and Total	28.55	33.48	29.54	4.02

These figures indicate very clearly that, on the medium loam soil existing at Waipio, it is impossible to store, in the upper

six feet of soil, more than 4½ inches of water, of which on an average, about 2½ inches is retained by the surface two feet of soil, the balance, some 2 acre inches, being held in the lower four feet, averaging about .5 inches per foot. This is obvious from the fact that the upper portion of the soil column is less compact than the lower portion, and possesses a lower initial percentage of moisture. Hence it is that when the heavy applications of water were made the amount in excess of that which the soil is capable of holding passes to lower depths and is lost. Samples were taken too soon after irrigation for an appreciable loss from evaporation or transpiration to have taken place. It is interesting to note in Table V where 54.02 inches and 88.58 inches are applied, the total amounts of water retained were 28.71 and 31.12 inches respectively, practically the same amount. In the former case, however, 53.14 percent of the applied water was retained as compared with 35.13 percent in the latter case. This is in marked contrast with the application of 19.82 inches, of which the soil retained 97.27 percent in a six foot depth.

It will be noticed in Table IV, where 1.84 inches of irrigation water were applied, that the average amount retained is slightly greater than the amount applied. This is probably due to the fact that 55 percent of the water applied in this case was retained in the surface foot of soil, the remaining portion being only sufficient to accelerate capillary action, hence drawing a small portion from lower depths.

TABLE VII.

Showing loss in moisture between irrigations.

Plot	Depth of Water Applied Inches	Per cent moisture		Loss in moisture per ft. of soil	
		2 days after Irrig.	15 days after Irrig.	Per cent	Inches
B	1.84	29.70	27.13	2.57	.35
C	5.64	31.46	27.67	3.79	.52
D	9.48	32.30	28.25	3.95	.54

That it is impossible to store, in soils of the same type, more than a certain quantity of water, regardless of the amount applied, is again shown very clearly in Table VII. As between the plots receiving 1.84 inches and those receiving 9.48 inches, fifteen days after irrigation, there is a difference of only 1.13 percent per foot of soil, or a total difference of .92 inches in six feet of soil. The average percentage after irrigation will be seen to be practically identical under the three varied conditions mentioned. Even directly after an irrigation (two days) the average percentage shows only a very slight variation. It is believed that

this fact is responsible for the uniformity in the yields as reported in Table III.

Summarizing the above, the following facts are brought out that should be of some interest to irrigated localities:

1. As the depth of irrigation increases the percentage of moisture retained in the upper six feet of soil decreases. 65 percent of a 9 inch irrigation and 47 percent of a 6 inch irrigation passes below six feet and is lost to the plant.

2. In no case did the amount of water retained, per irrigation, in the upper six feet of soil exceed 4.40 acre inches per acre—in other words this should be the limit of application for any one irrigation.

3. The average quantity of water retained per acre foot of soil was .54 inches, or to a six foot depth, totalled 3.24 acre inches.

4. Where a total of 54 acre inches or 1,466,316 gallons was applied 29 acre inches or 787,466 gallons was retained, as compared with 31 acre inches where the amount applied totalled 88 acre inches.

5. Aside from the greater percentage of loss where larger amounts of water are applied, the amount of moisture made available increases only to a slight degree.

6. It has been pointed out in a previous publication, Record, Vol. XVIII, No. 3, page 303, that this loss of irrigation water entails a leaching of the natural fertilizing elements in the soil, and in those applied in the irrigation water.

7. It is obvious that if 28.71 acre inches are made available by applying 54.02 acre inches and only 31.12 acre inches by applying 88.58 acre inches, the latter practice is a waste of labor and of water.

8. Exceptions should be noted to the deductions made in paragraphs 2 and 7, in the case of saline irrigation waters. With water containing an appreciable amount of salt, it is essential that a liberal excess of water be added to the land in order to leach out the added salts. It is an open question as to whether this should be done through adding an excessive amount of water at each irrigation or merely by adding excessive irrigations periodically.

IRRIGATING EVERY ROW VS. EVERY OTHER ROW.

An experiment has recently been harvested in which comparison was made between irrigating every row and every other row. The cane was not hilled and the trash was tied and bundled in the ordinary manner on the top of each hill. The canes in-

volved were D 1135, Lahaina, H 109, H 146, H 25, and Striped Mexican, second short ratoons. Water was applied at intervals of from 15 to 20 days and the water used each irrigation was carefully recorded by means of triangular V notch weirs. No attempt was made to regulate the quantity of water applied, the variation in the total amount being the natural result of the every other row irrigation as compared with irrigating every row.

TABLE VIII.

Comparing every row irrigation vs. every other row irrigation.

Treatment	Yield per acre (on all varieties)		Total water applied per acre		
	Cane	Sugar	Gallons	Ac. ft.	Ac. Inches
Irrigation every other row	51.94	5.43	1,440,000	4.42	53.05
Irrigation every row	52.03	5.45	1,980,000	6.08	72.96

There is a tendency among the laborers to fill the furrows fuller when irrigating every other row, hence the difference in the amount of water is slightly less than might be expected. The difference, however, is great enough to show that the cane did not respond to the larger amount of water. This is in accordance with the results previously stated in this article, and, although moisture samples were not taken here, it is believed that the uniform yields are due to the fact that the total water retained or made available to the cane was practically the same in both cases.

TABLE IX.

Showing effect of every other row irrigation on standard varieties of cane.

Variety	Irrigation every other row		Irrigation every row	
	Cane per acre	Sugar per acre	Cane per acre	Sugar per acre
H 109..........	55.49	6.09	54.73	6.03
Y. C............	52.63	5.92	51.37	5.78
H 146..........	45.95	5.42	48.97	5.78
D 1135.........	56.55	5.61	55.14	5.46

It will be noticed from the above table that, with the exception of H 146, there was a slight increase where the cane was irrigated every other row. The comparative yields from Lahaina cane are not included here as the plots were too badly infested with Lahaina disease to give reliable results.

This work is in its infancy, and the conditions under which the data have been collected do not represent the range of climatic

and soil conditions in the Islands, but it is believed that the general results are fundamentally correct, and will at least serve to open the road for further investigations.

H 456. Plant Cane, 18 months old, growing at about 550 feet elevation, on Oahu Sugar Company lands.

THE FERMENTING ORGANISMS WHICH CAUSE THE DETERIORATION OF CANE SUGAR IN STORAGE.

Dr. W. L. Owen, bacteriologist of the Louisiana State University, has brought together the results of his extensive investigation, covering several years, on the deterioration of cane sugars in a bulletin (No. 162) issued by the university. He studied the scientific aspects of the question as well as the purely practical. Probably the most important conclusion which his investigation leads to is that the deterioration of sugars is due mainly to the action of molds. He was led to this conclusion from the fact that his investigation of the other forms of microorganisms present in sugars, bacteria and yeasts, showed that they are limited in their action by differences in environment to

a greater extent than are the molds. Deterioration begins, of course, in the molasses surrounding the grains of sugar and it was found that this medium is much more favorable to the action of molds than to that of bacteria or yeasts.

The conclusions as a whole are not summarized in the bulletin, but the following extracts will serve to indicate what they are:

"It is natural to suppose that the variation in the composition of sugars of different types would represent conditions of unequal suitability for the development and activities of the different groups of micro-organisms occurring therein. Under what conditions does the one or the other group gain the ascendancy? From the superficial consideration of the subject, we might well conclude that the conditions differentiating the possible activities of the three groups of micro-organisms in sugars [molds, yeasts and bacteria] might be classified as follows:

(1) Degree of density of the molasses film.

(2) Its nutritive value.

(3) Its degree of acidity or alkalinity."

"We have, therefore, the following data upon the limits of density in which the respective groups of micro-organisms are able to destroy sucrose:

(1) Mould culture: Rapid deterioration in 69 Brix solution.

(2) Torula [yeast] culture: Moderate deterioration in 64 Brix solution.

(3) Bacteria culture: Rapid deterioration in 52 Brix solution; no deterioration in 60 Brix solution."

"The identity of the species of bacteria in sugar with the potato group of bacteria is clearly indicated in the morphological and physiological characteristics of the individual species in the two groups."

"The comparatively low maximum density in which these bacteria are capable of developing, suggests that their deteriorative action upon sugars is largely confined to fairly moist sugars, in which the molasses films have been much diluted by the absorption or addition of moisture."

"The limit of sucrose concentration in which the cultures (bacterial) seem capable of inducing any appreciable action is between 46 and 55 Brix."

"A critical review of the data now extant upon the subject shows that no positive results have been obtained from the inoculation of sterile sugars with pure cultures of bacteria except in cases where the sugar used would be considered abnormal as regards its moisture content."

"From the results of our experiments upon the comparative nutritive requirements of the three groups of micro-organisms in sugars, we may conclude that their rank with regard to the possibility of their having these requirements satisfied in most any type of sugar is as follows:

(1) Moulds,
(2) Bacteria,
(3) Torula."

"The cultures of bacteria have a low tolerance or acid and alkali when grown in sucrose solutions."

"The above table gives the results of an experiment on the deterioration of a syrup of varying acidities by a torula culture. It will be noted that the action of the torula was practically the same in all cases and that no inversion took place."

"A comparison of the results given in the two tables above shows that the inverting action of the mould cultures upon the sucrose in the different solutions was very pronounced."

"We may well assume from these experiments that moulds are not easily rendered inactive toward sucrose by slight changes in the reaction of the solution."

R. S. N.

THE PORTABLE PLANTATION SAWMILL.

We show in the accompanying illustrations a portable sawmill employed at the Honokaa Sugar Company, for making railroad cross ties, firewood, etc. The saw is rigged on a steam plow frame and hauled about from place to place where timber is available by steam plow engine.

The lower picture shows railroad cross ties in the foreground prepared by this outfit.

EFFECT OF THE PURITY OF THE JUICE ON THE PURITY OF THE FINAL MOLASSES.

The last Annual Synopsis of Mill Data shows that the average purity of the final molasses was about one percent lower for the season of 1918 than for that of 1917. The report claims this to be due to improved work in the boiling houses. The question was raised at the last annual meeting of the H. S. P. A. whether this drop in purity of the molasses could not be accounted for by the lower purity of the juices. It is sometimes claimed that the purity of the molasses will follow that of the juice, up and down. The opposite claim is also made, that a high purity juice will give a low purity molasses. As a matter of fact there is no proof for either one of these statements. Some of our factories which have high purity juices get low purity molasses, and vice versa. In the investigations at the Experiment Station molasses resulting from both high and low purity juices have without distinction been reduced to low purities. For instance from high purity juices:

H. C. & S. Co.	28.14
Oahu	30.32
Hawaiian Sugar	28.08
Hilo	30.13

And from low purity juices:

Ewa	28.13
Kahuku	29.62
McBryde	30.16
Koloa	28.72

That the drop in the average purity of the final molasses last season was not due to the low purity of the juices can be seen from the table below, in which the purities of the molasses and syrup of different plantations for the last two seasons are given, with the increase or decrease in each. The plantations showing a decrease in molasses purity are given first, followed by those having an increase in molasses purity. Comparing the figures in the third column of the molasses table with those in the syrup table, it will be noted that they bear no constant relation to each other. The proportion of plantations on which the purities of the molasses and the syrups went in the opposite directions, that is increased or diminished, is slightly greater than those in which they went in the same direction.

Factory	Gravity Purity—Molasses			Apparent Purity—Syrup		
	1917	1918	Increase or Decrease	1917	1918	Increase or Decrease
H. C. & S. Co.	42.51	40.44	—2.07	88.58	88.11	—0.47
Maui Agr.	42.77	41.04	—1.73	88.27	86.34	—1.93
Oahu	41.00	39.07	—1.93	86.40	87.05	+0.65
Ewa	39.50	37.34	—2.16	82.07	83.05	+0.98
Pioneer	39.08	38.39	—0.69	88.25	86.20	—2.05
Waialua	40.10	39.60	—0.50	85.20	86.20	+1.00
Olaa	39.80	38.30	—1.50	86.00	86.50	+0.50
Onomea	35.11	34.90	—0.21	86.60	87.30	+0.70
Kekaha	41.20	38.77	—2.43	87.60	86.24	—1.36
Hilo	39.25	36.71	—2.51	87.88	86.90	—0.98
Honokaa	41.91	38.90	—3.01	86.67	81.01	—5.66
Lihue	38.50	37.60	—0.90	85.60	82.70	—2.90
Pepeekeo	39.02	38.45	—0.57	87.60	88.57	+0.97
Paauhau	38.17	38.10	—0.07	88.16	84.50	—3.66
Kahuku	41.63	37.58	—4.05	83.80	81.75	—2.05
Honomu	36.60	35.70	—0.90	87.30	86.70	—0.60
Kaiwiki	45.00	42.43	—2.57	86.63	84.99	—1.64
Waianae	39.79	39.11	—0.68	84.71	85.15	+0.44
Haw. Sug.	40.03	40.35	+0.32	86.30	86.03	—0.27
Hakalau	36.80	38.40	+1.60	87.69	85.30	—2.39
Wailuku	38.40	39.59	+1.19	88.31	85.70	—2.61
McBryde	39.00	39.68	+0.68	83.40	83.50	+0.10
Waiakea	41.67	41.80	+0.13	84.99	86.43	+1.44
Haw. Agr.	39.63	40.63	+1.00	87.33	86.92	—0.41
Lihue, Han	37.73	40.00	+2.27	86.90	86.20	—0.70
Laupahoehoe	38.21	42.58	+4.37	88.28	87.13	—1.15
Makee	36.05	36.90	+0.85	83.84	82.39	—1.45
Hutchinson	39.63	40.72	+1.09	86.40	85.10	—1.30
Kilauea	38.56	40.10	+1.54	81.54	81.80	+0.26
Kaeleku	38.00	38.00	0.00	85.06	84.00	—1.06

Further evidence on this same point is furnished by Prinsen Geerligs in the latest number of the International Sugar Journal.* In discussing the factory results in Java for the season of 1917 he gives the following figures with his interpretations of them:

Purity of Raw Juice	Purity Final Molasses
87.0	28.2
87.6	29.4
80.9	29.5
89.4	29.7
86.8	29.7
83.4	36.5
86.8	36.8
82.8	37.3
87.5	37.4
86.1	39.9

This shows no direct relation between the quotients of purity of the raw juice and those of the final molasses."

R. S. Norris.

* I. S. J., October, 1918, page 462.

2

BUD VARIATION; A REVIEW OF U. S. D. A. BULLETIN 623, "CITRUS-FRUIT IMPROVEMENT: A STUDY OF BUD VARIATION IN THE WASHINGTON NAVEL ORANGE," WITH REFERENCE TO THE PRACTICAL IMPORTANCE OF BUD VARIATION IN THE SUGAR CANE.

By E. L. Caum.

U. S. D. A. Bulletin 623 * gives the results of several years' investigations on the occurrence and economic importance of bud variations in the Washington Navel orange in California.

The Washington Navel orange is the most important citrus variety grown in California. Itself a bud variation or sport from the Brazilian 'laranja Selecta' or Selecta orange, it was brought into the United States in 1870, budded onto orange stocks in the greenhouses at Washington, and in 1873 distributed to growers in Florida and California.

The first record we have of this variety is that it was propagated by a Portuguese gardener of Bahia about 1820. The Selecta, whose relationship to the Washington Navel is shown by the frequent occurrence of Navel fruit in Selecta orchards, is supposed to have been introduced from India by the early Portuguese explorers and settlers.

In the distribution of the young budded trees, two were sent to Mrs. L. C. Tibbets of Riverside, Cal. At the present time many of the trees of the Washington Navel grown in California are descendants of these two trees, and there is every reasonable assurance that all the trees in the experimental plats are descendants of these trees, and but two or three bud generations removed.

In 1909 Mr. Shamel began a study of individual Washington Navel trees in Southern California. This study revealed the presence of several strains of trees and fruits showing marked and important characteristic differences. A 'strain' means a group of individuals of a horticultural variety which differ from other individuals of the variety in constant and recognizable characteristics which are capable of perpetuation through vegetative propagation.

* United States Department of Agriculture Bulletin No. 623, 'Citrus-Fruit Improvement: A Study of Bud Variation in the Washington Navel Orange,' by A. D. Shamel, L. B. Scott and C. S. Pomeroy. Professional Paper, July 22, 1918.

It was thought at first that these strains might be due to climatic or soil conditions, penetration of scion by stock, or some other external influence. However, the fact that often several distinct types of fruit and foliage were found on a single tree, and sometimes on the same limb, proved that they were true bud variations. This was further proved by showing that these different types could be isolated and perpetuated through bud selection.

These bud variations of the Washington Navel orange are of great economic importance, since the frequent occurrence of sports of inferior grade and the propagation of these strains in budding new trees would soon result in the loss of the reputation and prestige held by this variety.

The authors state that while the total number of strains of the Washington Navel is unknown, thirteen important variations have been found in the experimental plats. Many other less marked departures from type have been found, but these are at present supposed to be of slight importance. As to the relative amount of variation, the percentage of off-type trees in commercial orchards ranges from 10% to 75% of the total number of trees in the orchard. The general average is around 25%, most of which are inferior to the normal Washington type. As the newer orchards show a greater percentage of off-type trees than the older ones, it shows that the haphazard selection of bud-wood is causing the deterioration of the variety through the perpetuation of a larger and larger proportion of undesirables.

The investigation was undertaken "(1) to ascertain the variation which has taken place in the Washington Navel orange through bud variation; (2) to determine the extent to which undesirable variations have been propagated, as shown by the percentage of such undesirable trees existing in the present bearing groves; and (3) through improved methods of propagation to control the extent to which undesirable variations shall enter into the population of future commercial Washington Navel orange groves."

In the course of these investigations performance records were made of over 700 trees. These were records of the number and commercial quality of the fruits borne by individual trees during a period of years, together with observations and descriptive notes. Naturally these notes included a full account of the number and type of sports. These sports, while some are as good as the normal, and are propagated as commercial varieties, are usually fruits of no commercial value. They may be dry, bitter, odd-shaped, thick-skinned, rough, corrugated, and the

like. Frequently they are correlated with a distinctive type of vegetative growth.

At first the investigation was intended to discover the effect of the off-type trees on the production of the grove as a whole, but it was soon found that individual off-type fruits occurred, and that the fruits of the Golden Nugget strain, for instance, on trees of the normal Washington type were not to be distinguished from fruits borne by Golden Nugget trees. This discovery soon led to others, such as limb sports of unprofitable strains on otherwise profitable trees, etc. These finds proved absolutely that the accidental propagation of bud sports was responsible for the diverse strains of trees in Washington Navel orchards. The performance records will pick out the trees of unprofitable strains, as well as the otherwise normal trees which bear a large proportion of unprofitable sports, and hence will show which trees should be avoided in choosing bud-wood, and which should be eliminated. This elimination has been effected by top-working undesirable trees with select bud-wood.

The authors state that as a result of their investigations more than 40,000 undesirable citrus trees in California have been top-worked with buds from the best trees in the experimental plats, and that so far not a single failure of the buds to transmit the parental characters has been observed. These buds were 'pedigreed,' that is, the twigs chosen had each a fruit attached, and it was supposed that the fruit showed the inherent possibilities of the twig. So far as the results have been observed, this supposition was correct.

But when we come to compare bud variation in the orange with bud variation in the sugar cane, we meet difficulties.

In any work which has as its object the improvement of plants by means of selection, it must be remembered that there are two kinds of variation—that due to hereditary traits and that due to environmental conditions. In the science of Genetics it is practically an axiom that 'acquired characters are not inherited.' While there are cases which seem to point the other way, the vast bulk of the evidence favors the axiom. The best that can be said for the odd cases is 'not proven, one way or the other.'

In the class of environmental variations in plants we have those differences which are due to soil conditions, climatic conditions and the like. These are well shown in the sugar cane. Certain canes will grow well in the lowlands, but become stunted or refuse to grow at all at high elevations. Certain soils will not support one variety of cane, while another variety will flourish there. But it is obvious that the characteristics acquired in this way are

not hereditary. If they were, cuttings from a lowland cane which had made a poor growth for several generations in the mauka lands, say, would keep that same type of growth when brought down to the low elevations. But we know that under those circumstances the cane will revert to its former vigorous growth. Experiments of this kind have been made with many kinds of plants, and in no case has it been definitely proven that the acquired characters of the parent were transmitted to the offspring.

The variations of the hereditary class come under two general heads—those due to hybridization and the consequent splitting up and rearrangement of the unit characters, and those due to bud variation. The latter are commonly called "sports."

The variations due to hybridization are well shown in our seedling canes. The differences are so great that it is next to impossible to find a cane in a given batch of seedlings that bears more than a very superficial resemblance to either parent.

Differences due to bud variation or sporting are of another type, and their cause is not definitely known. Various explanations have been offered, but they are only guesses at best. The phenomenon of bud variation in plants has been known for many years, but it is only comparatively recently that commercial advantage has been taken of it. The case of the Washington Navel oranges will serve to illustrate the economic importance of one phase of it. Another well-known case is that of the paper-shell almond, which arose as a sport from the original hard-shelled type.

It has only been within the past few years that bud sports of the sugar cane have been recognized as such, and practically every case on record has been one of variation in the most noticeable characteristic of the cane—its color. There are many cases known where striped cane has given rise to a self-colored variety, which will come true to type from cuttings. The Striped Mexican often throws self-colored cream or red sticks, and the Yellow Caledonia is a sport from a striped purple and yellow cane, which in turn is a sport from a self-colored purple cane. On the other hand, solid colored canes will throw striped sports, as in the case mentioned above, and in varieties which have been found in the Station fields, such as striped Lahaina, striped Badila and striped D 1135. Other cases are like that of white D 1135, where a self-colored red cane gave rise to a striped cane and this in turn to a self-colored white sport.

However, variations of this kind have no commercial significance, unless they are correlated with other characters, not ap-

parent to the eye, which have. In that case one character, of no value in itself, may show that another character, which is of value, is present. And this brings up another point, that of correlation of characters, which will be briefly discussed a little later.

This paper was intended to show the relation between the economic importance of bud variation in the orange, as set forth in the Department of Agriculture bulletin which was reviewed at the beginning of this article, and the same phenomenon in the sugar cane. It is seen from that bulletin that the important variations of the orange are easily recognized, and that the method of dealing with them is comparatively simple. The sugar cane is a different proposition. Of the two items of primary importance in sugar cane culture, heavy tonnage of cane and high sugar content of the juice, only the first is apparent to the naked eye.

Both these items are what are known as fluctuating variations; that is, the variation is gradual, and proceeds back and forth within certain limits. This is opposed to mutation, where the variation is quite marked and comparatively stable. The methods of dealing with these two forms are different—mutations may be picked out and propagated immediately, as was done at the Station with a cane which threw some sticks with multiple eyes; while fluctuating variations must be carefully and continually selected, the best variants being made the parents of the next generation. The classic example of selection of a fluctuating variant is the case of the sugar beet, where the sugar content of the root was raised from 10 to 18 per cent. Beyond this it was impossible to go, as the tendency to revert to a lower sugar content was too great. This work necessitated the chemical examination of thousands of beet roots, only the seed of the best being planted.

Another method of isolating variations which are not visible to the eye is by means of correlative characters. This is a condition where two characters, with no essential or necessary relationship between them, always appear together. For instance, when we see a plant with parallel-veined leaves, it is safe to say that the seed will have only one cotyledon. There is no particular connection between a monocotyledonous seed and parallel-veined leaves, but the two always appear together. There are many other pairs of similarly related characters, such as brown flowers and black fruits in one variety of Belladona, and greenish flowers and yellow berries in another variety. Many cases of correlated characters are found all through the animal and plant world.

In the study of bud variation in the sugar cane, as contemplated by the Department of Botany of this Station, it will be

necessary to attack the problem from two sides—selection of gradual variations and determination of correlative characters.

In the matter of selection, considerable data have already been gathered, but have not been fully worked up. Likewise, by means of printed blanks, many canes have been examined and carefully described, in hopes of discovering a character, easily seen in the field, which is linked with a high sugar content in the juice. By the first method, continued selection through several generations, we may be able to develop a strain of sugar cane which is considerably higher in sugar content of the juice and tonnage of cane than the normal variety. By the second method, if we can find a morphological character that is linked with a high production of sugar, the problem will be immensely simplified. In that case it would only be necessary to look for the morphological character, knowing that the other would be there as a matter of course.

About fifteen years ago Dr. Kobus, then director of the sugar Experiment Station at Pasoeroean, Java, began work on this same problem, starting out by selecting his plants on the basis of available sugar in the juice. In this selection he used the entire stool, mixing the juice and sampling the mixture. He claimed that this gave more satisfactory results than simply taking the best stalk in the stool. By this method he said that he could effect an increase of 10% in the production of sugar, if the selection were carried on for three or four generations. Among other things, he incidentally discovered that the heaviest stools were the best in available sugar. The discovery of this correlation between high sugar content and weight of stool simplified matters, and his method thereafter was to select 20% of the heavy stools and plant the best half of these. They were planted, of course, in the fields set aside for the propagation of cane for seed, all Javanese crops being plant crops. For various reasons ratooning is not practiced. His experiments further told him that rich plants from rich parents consistently gave a better yield than poor plants from poor parents. In a selection covering five years, the rich plants made an increase of 40%, while the poor plants decreased 60%. Even after a single selection, the plants remained higher in sugar than the unselected plants for three or four generations.

It will be seen from this that, if Dr. Kobus' results hold good here, the problem will be as good as solved, since he has found a correlation between the two important factors, one of which is easily visible to the eye. However, there has been considerable objection raised to this work. Other Dutch investigators had worked on the problem of selection, attacking it from various

angles, and at the Congress which met at Soerabaja, Java, in 1907, a general resumé of these experiments and their results was given. The consensus of opinion seemed to be that the whole thing was a failure. Van der Stok, Kobus' successor at Pasoeroean, had no confidence in selection as a method of increasing yield, and gave it as his opinion that the plan of picking the best seed—the best tops from the best fields, selected in average from the best plants—would have an influence on production fully equal to that of the most effective combination of other methods of selection.

As the matter stands now, more of this work has been done in Java than in any other sugar-growing country, and opinion there is divided. Kobus and some of his successors are strong advocates of asexual selection, while Van der Stok and his followers have no faith in it. The plan of this department is to repeat Dr. Kobus' experiments, with any additions or alterations that may seem good to us, to see whether his results will hold under our conditions. The particular one of these conditions is the Hawaiian practice of ratooning cane, which is not done in Java, and which in consequence did not enter into Kobus' calculations. It is easy to see why, theoretically at least, the increased sugar content would remain constant when every crop is a plant crop, but it is entirely possible that there might be considerable degeneration from the artificially acquired standard when the cane is carried through ratoons. If we can isolate a strain by means of selection of fluctuating variations that will be constant, well and good. But it is likely that there would have to be continual selection to keep the strain up to standard. The discovery of a fixed morphological character that is correlated with the particular factors we want—leaving aside for verification the contested correlation found by Kobus—will very probably eliminate the need for this continuous chemical selection, and after a few years' field selection for this morphological character give us a strain of sugar cane that may in time replace most of the varieties now grown on our plantations.

This work is proceeding on the assumption that there is such a fixed morphological character which is correlated with a high sugar content of the juice. There may be no such character. There are any number of correlated characters known in the animal and plant worlds, and there may be numerous sets in the sugar cane, but the particular set we desire may be nonexistant. That can be discovered only by experimentation. If there is such a factor correlated with the one desired, we shall endeavor to find it. If there is not, we shall have discovered

that our problem must be attacked from another angle, and that the idea of correlative characters must be relinquished in favor of the only one left us, aside from the raising of innumerable seedlings—that of attempting to fix a fluctuating variation.

EARNINGS REQUIRED TO RENDER IMPROVEMENTS PROFITABLE.*

Table for computing average annual earnings necessary to absorb general investment in a given time, based on applying six percent interest, compounded annually, to both cost and earnings.

Before installing new machinery or making other improvements to plants, prudent manufacturers compare the estimated saving in operation which will be effected, with the cost of the improvement. To do this, it is necessary to know:

1st. The initial cost of the improvement.

2d. The estimated life or period of usefulness of the improvement.

3d. The amount of interest, compounded annually, which will be chargeable to the improvement during its estimated life or period of usefulness.

4th. The necessary average annual earnings of the improvement after crediting the earnings from year to year with compound interest on the same from the time they are earned until the end of the amortization period.

To ascertain the above requires a considerable amount of figuring which cane cán be saved by using the tables herewith.

EXAMPLE.

An investment of $46,800.00 is to be taken care of on a 6% interest basis in 15 years. To find the answer, charge the following:

1st. $1.00 at compound interest for 15 years amounts to $2.39655749, as shown in Table I. $46,800.00 multiplied by 2.39655749 equals $112,158.89, which is the total amount of principal and interest to be absorbed.

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* From "Concerning Sugar," October, 1918, page B. 30.

2nd. $1.00 earned at the end of each year for a period of 15 years, plus 6% compound interest on each dollar from the time it is earned until the end of the period, amounts to $23.2759657, as shown in Table II.

3d. It therefore will require as many dollars in average yearly earnings to absorb $112,158.89 as $23.2759657 is contained therein, $4,18.6567.

DETAILED FIGURES OF ABOVE EXAMPLE.

Investment	$46,800.0000
	1.06
Invest, including interest..	49,608.0000
1st Reduction	4,818.6567
	$44,789.3433
	1.0600
	$47,476.7039
2d Reduction	4,818.6567
	$42,658.0472
	1.06
	$45,217.5300
3d Reduction	4,818.6567
	$40,398.8733
	1.06
	$42,822.8057
4th Reduction	4,818.6567
	$38,004.1490
	1.06
	$40,284.3979
5th Reduction	4,818.6567
	$35,465.7412
	1.06
	$37,593.6857
6th Reduction	4,818.6567
	$32,775.0290
	1.06
	$34,741.5307
7th Reduction	4,818.6567
	$29,922.8740
	1.06
	$31,718.2464
	$31,718.2464
8th Reduction	4,818.6567
	$26,899.5897
	1.06
9th Reduction	$28,513.5651
	4,818.6567
	$23,694.9084
	1.06
	$25,116.6029
10th Reduction	4,818.6567
	$20,297.9462
	1.06
	$21,515.8230
11th Reduction	4,818.6567
	$16,697.1663
	1.06
	$17,698.9963
12th Reduction	4,818.6567
	$12,880.3396
	1.06
	$13,653.1600
13th Reduction	4,818.6567
	$ 8,834.5033
	1.06
	$ 9,364.5735
14th Reduction	4,818.6567
	$ 4,545.9168
	1.06
	$ 4,818.6718
15th Reduction	4,818.6567
	.0151

RULE.

1st. Multiply the initial cost of the improvement by the sum to which $1.00 increases in the number of years in which the investment is to be absorbed, as shown in Table I.

2d. In Table II find the sum that $1.00 earned at the end of each year amounts to at the end of the number of years in which the investment is to be amortized and divide the same into the product of the first step.

TABLE I.

Amount to which $1.00 increased in 1-20 years at 6% compound interest:

1.	1.0600000
2.	1.1236000
3.	1.1910160
4.	1.26247696
5.	1.33822551
6.	1.41851903
7.	1.05363014
8.	1.59384790
9.	1.68947877
10.	1.79084742
11.	1.89829824
12.	2.01219609
13.	2.13292776
14.	2.26090336
15.	2.39655749
16.	2.54035084
17.	2.69277184
18.	2.85433810
19.	3.02559838
20.	3.20713419

TABLE II.

Amount to which $1.00 earned at end of each year increase in 1-20 years, at 6% compound interest:

1.	1.00
2.	2.06
3.	3.1836
4.	4.374616
5.	5.6470929
6.	6.9753184
7.	8.3938375
8.	9.8974677
9.	11.4913157
10.	13.1807939
11.	14.9716405
12.	16.8699384
13.	18.8821342
14.	21.0150620
15.	23.2759657
16.	25.6725229
17.	28.2128733
18.	30.9056453
19.	33.7599837
20.	36.7855819

REPORT OF COMMITTEE ON CURING AND MARKETING.*

By R. S. Norris.

The Committee on Curing and Marketing sent out a list of questions to the members of the Association and received replies from a large majority of the plantations. These are arranged in order, by islands, with a short discussion of the replies following. The information conveyed in these replies is without doubt, I believe, the most valuable that can be obtained locally upon these subjects, because it is from the men who know most about them from practical experience.

Replies that were merely negative have been omitted.

* Presented at the 16th annual meeting of the Hawaiian Chemists' Association, Oct. 30, 1918.

QUESTION 1: What benefit, if any, have you derived from cooling first massecuites in a crystallizer before centrifugaling?

Horace Johnson, C. Brewer & Co.:

Most of the C. Brewer & Co. mills make but one marketable sugar massecuite, which has a purity of ± 73 and yields a sugar of 96.5 polarization and a molasses of ± 52. This strike is dropped directly to the mixer and dried. There is no advantage in cooling such a strike in the crystallizers before drying.

H. F. Hadfield, Hilo Sugar Co.:

When a first massecuite is dropped into a crystallizer from the pan the mother liquor continues to exhaust itself and build on the grain, leaving a molasses of low purity.

K. W. Kinney, Hakalau Plantation Co.:

Greater recovery in sucrose and lower purity of 1st molasses. The lower the first molasses the greater the boiling-house recovery.

R. J. Richmond, Hawi Mill & Plantation Co.

We do not as a rule use our crystallizers for first massecuites during the week, a second grade of commercial sugar, built up with first molasses on cut strikes on No. 1 massecuites, being cooled in them; but for convenience we leave a strike or two of No. 1 in them Saturday night till Monday or Tuesday. If this sugar has been run into the crystallizers at a fairly high density and allowed to cool down to ordinary temperatures, the yield is greater, I believe, although I have no figures to prove this; also the grain is improved, being sharpened and hardened, and the molasses is lower in purity.

P. W. Alston, Wailuku Sugar Co.:

The chief benefit derived from cooling the first massecuites in a crystallizer is the prevention of caking of the sugar in the bags in storage, and a decreased tendency for the sugar to sweat. A lower purity of molasses is obtained, allowing of a higher purity massecuite and a better sugar.

A. Krafft, Oahu Sugar Co.:

An extra drop in the purity of the molasses from 2 to 4 points is obtained. The sugar is freer and occupies less room in the bags.

W. K. Orth, Koloa Sugar Co.:

A few times when the massecuite had to be left in the mixer until quite cool the sugar did not cake as much in the centrifugals and bags, the purity of the molasses was lower, the drying was slower, but was compensated for by quicker discharging. Keeping massecuites over night warmed in jacketed crystallizers, always gave considerably lower molasses than resulted from massecuites not so treated. As the massecuite is liable to become very stiff, provision has to be made to mix first molasses with it if necessary.

It is apparently not a common practice to cool first massecuites before centrifugalling. The advantages are evidently not considered strong enough to warrant its use as a regular practice in many factories.

QUESTION 2: Have you used any of the following methods for improving the drying of low-grade massecuites?

(a) Mixing hot molasses with the massecuite as it is delivered into the centrifugals.

(b) Warming the massecuite in the mixers by circulating hot water through a system of pipes.

(c) Blowing jets of steam into centrifugals.

(d) Diluting massecuite with water or dilute molasses.

Kindly describe in detail all methods you have used and the advantages and disadvantages you have found in their use.

G. Giacometti, Olaa Sugar Co.:

(a) and (b)—No experience.

(c)—Steam in centrifugals tried and discarded on account of rising purity of molasses.

(d)—It is the regular practice in this mill to dilute massecuites in the crystallizers with water after cooling. Great improvement in drying and no effect on final molasses.

Horace Johnson, C. Brewer & Co.:

From time to time the different factories have used, in order to improve the drying of the low-grade massecuites, the following methods:

(a) Mixing the hot molasses with the massecuite as it is delivered into the centrifugals.

(b) Warming the massecuite in the mixers by circulating hot water through a system of pipes.

(c) Blowing jets of steam into centrifugals.

(d) Diluting massecuites with water or molasses in the crystallizers.

(e) Diluting the massecuite with hot diluted molasses just before it enters the mixer.

All of the above methods have been used with more or less success, but they all have drawbacks. If not carefully regulated there is a loss of sucrose due to remelting of crystals, and if the massecuite is diluted too much there is a loss of crystals through the centrifugal screen.

H. F. Hadfield, Hilo Sugar Co.:

In experimenting with low-grade massecuite drying, several interesting points stand out prominently. Centrifugal force influencing a massecuite throws out the heaviest and consequently the largest grains to the screen first. Examination of the screen of 625 holes per square inch under a strong glass will show that the holes are very much larger than the grains of sugar. Therefore it may be assumed that at the start a centrifugal machine will lose grains of sugar into the molasses. As soon as the machine is speeded up grains of sugar begin to penetrate the screen until others pack themselves in such a way as to hinder the passage, hence the reason that there are more grains lost during the first part of drying than during the last part.

(a) Warming a massecuite too much will cause the grains to go through easily, as the less dense liquid enable the crystals to get through. The heaviest and largest crystals having accumulated against the screens, the smaller and lighter ones pack up till the last to pack are the smallest. After this the molasses, completely separated from the crystals, has to penetrate the mass of crystals before the sugar is fit for discharging. The larger the number of small-grain crystals there are in the massecuites, the longer it takes the molasses to penetrate, which explains why false-grain strikes take longer to dry than clean-boiled ones. In examining a layer of low-grade sugar in the centrifugal machine under a glass it can be distinctly seen that the larger crystals are against the screens, diminishing in size as the surface is reached. When a large-grain strike is boiled without false grain the molasses penetrates the layer of crystals straight away and no layer of molasses is seen, the whole taking less time to dry. When a small-grain strike is boiled, the molasses will be found quite exhausted in a layer on the outside surface within twenty minutes after starting, the sugar between this layer of molasses and the

screen being perfectly dry. A device to suck off this molasses would be found time-saving.

(a), (b), (c), (d)—These four methods all tend to hasten the rate of drying of low-grade massecuites at the expense of losing sugar, either in melting of grain or through the screen.

H. D. Beveridge, Onomea Sugar Co.:

I have tried all of the above methods for improving the drying of low-grade massecuite.

(a)—Found the molasses did not mingle with massecuites sufficiently to be of much benefit.

(b)—Improves drying, but increases purity of molasses drained off.

(c)—Same as (b).

(d)—We have been using the following method at Onomea the past three seasons:

Warm waste molasses of 120° to 140° F. is fed into the magma pump supply tank, through a small pipe, in sufficient quantities to reduce the Brix of massecuites to 92°-93°. This method assists the drying naturally, with a small increase in the purity of the molasses drained off. I believe it possible, given a large enough centrifugal capacity, to handle low-grade massecuites of 96°-98° Brix without diluting, and produce an average waste molasses of 32° gravity purity.

John J. Muller, Pepeekeo Sugar Co.:

We have used all the methods mentioned, now we are using dilute molasses mixed with a solution of caustic soda.

Some years ago we used hot molasses. This worked fairly well, only when the molasses started to come through, the machines swayed too much. Hot water pipes also worked fair, but we cut them out on account of leakage. Steam jet also helps, but raises the purity of the molasses.

E. T. Conant, Honomu Sugar Co.:

We use jets of steam.

K. W. Kinney, Hakalau Plantation Co.:

Yes.

(a)—Mixing waste molasses heated to 70° C. with low-grade massecuites as it is delivered into the centrifugals lessens time of drying. The machines vibrate so at times that they are often

put out of commission. Dread of accidents and loss of time in repairing caused us to discard the method.

(b)—Warming low-grade massecuite with hot water of 85° C. circulated through coiled 1″ pipe laid at bottom of mixer expedites drying to a very marked degree and the method is clean. We have worked it here to good advantage when our low grades became stubborn for purging and we would do it again should occasion arise.

(c)—Blowing jets of steam against the outer wall of the baskets injures them. Some sugar grains are also remelted and lost.

(d)—Diluting low-grade massecuite with very dilute waste molasses or warm water (condensates) I think is the best of all these methods; i. e. if one can arrange it so that the liquefying is done as massecuite is delivered to the mixer. There is an appreciable saving in time through better purging and a lesser quantity to work through than when adding molasses in the baskets. We adopted the system at the commencement of last season.

J. M. Reynolds, Laupahoehoe Sugar Co.:

We have tried (a) mixing hot molasses with massecuite as it is delivered into the centrifugals; and (c) blowing jets of steam into centrifugals. With (a) we believe the massecuite dries much quicker, with only a trifle increase in purity in final molasses; and with (b) a quick drying but greater increase of purity.

E. T. Westly, Paauhau Sugar Plantation Co.:

Yes, with (a) and (d).

(a)—Have only tried it on a small scale. Buckets of hot molasses were poured into the centrifugal while it was loaded in motion. The results varied a lot, but it helped the drying in all cases.

(d)—In 1915 we used to reduce the Brix of our third massecuite about 5 degrees with water. Since then we have been using diluted hot molasses, but only when the massecuite is very sticky.

J. E. Biela, Kohala Sugar Co.:

I have used steam on the outside of the baskets extensively when drying low-grade sugars, and found it of advantage when drying viscous material which has been boiled blank. I have not

detected any appreciable difference in the purity of molasses when using steam nor any decrease in recovery, as is quite often pointed out. If there is any grain destroyed, it is only the very fine grain which would have, under ordinary conditions, passed out with the molasses any way. If there is more sugar dissolved it is due to faulty placing of the steam arrangement and injudicious use of steam. I have lately experimented with second massecuites boiled blank to 96° Brix. This massecuite in the first instance was boiled from molasses of 53° purity and remained in the crystallizer for 18 days. The drying was very slow and the molasses resulting from this material was 33° apparent purity. As I have no other arrangement, I used water to dilute the product to 92° Brix, which improved the drying considerably, but the purity of molasses was raised to 36.5°, a difference of 3.5°, while in the second trial with massecuite of similar composition the purity of molasses was raised 4° with the use of water as dilutant. It shows that the use of water should be avoided in the performance of this kind of work. I have not used diluted molasses for diluting viscous massecuites, but think that this product will, outside of steam, most likely solve the problem without incurring any loss. I am skeptical about constant contact of massecuites with hot surfaces, i. e., steam pipes or hot water circulating arrangements in the mixer. A considerable percentage of impurities will be, no doubt, through such a system returned into the boiling-house while they otherwise would have passed out with the molasses.

R. J. Richmond, Hawi Mill & Plantation Co.:

(a)—I have tried running in hot molasses with low-grade massecuites, but, as we are without proper facilities for doing so, did not have success with it.

(b)—Also tried pipes in bottom of mixer, heated by exhaust steam, which caused local overheating, the mass being too hot in the immediate vicinity of the pipes. This is to be altered shortly and hot water from condensates connected up. I think that some means of slowly starting or mixing the massecuite, while at the same time heating it, might also help; for instance, a slowly-revolving arrangement of small pipes after the fashion of a Wetzel pan.

(c)—Have not tried steam in centrifugals for accelerating drying of low grades.

(d)—In cases where crystallizer low-grade massecuite gives trouble in drying I thin up with water, stirring till the water has diluted the molasses, the centrifugalling being much improved. I formerly tried hot molasses, but it did not give like results.

The purity of the resultant molasses from the massecuites thinned with water was not appreciably increased.

V. Marcallino, Hutchinson Sugar Plantation Co.:

(a)—I formerly used the method of mixing hot molasses with the massecuite as it was delivered into the centrifugals. The molasses was heated to about 140° F. by means of a perforated steam pipe in the bottom of the tank. After starting the machine, the molasses was allowed to run in alone for a few seconds, then massecuite and molasses together until the machine was sufficiently charged, and finally, molasses alone for a few seconds longer. I believe this method will appreciably quicken the purging of a slow-drying massecuite, but would prefer not to use it when the massecuite is drying well without it.

(b)—I object to this method owing to the difficulty in properly regulating the temperature of the massecuite, the result usually being higher purity molasses. However, I have found it a distinct advantage in the case of a very sticky, poorly-grained massecuite, which it was necessary to force through the machines when pressed for space.

(c)—No experience, but believe that this method will result in a higher molasses.

(d)—No experience.

Since the replacement of the twelve-30-inch machines by seven 40-inch machines, I have not used any of the above methods for improving the drying of the low-grades. If pressed for room, however, I expect to try the mixing of hot molasses with the massecuite at the magma pump, the same being further mixed by means of the stirrer in the mixer. This method, I understand, is being successfully used in other mills.

Joseph Steinberg, Hawaiian Agricultural Co.:

By using methods (a) and (d) the massecuite will dry a great deal better. The disadvantage in methods (a) and (b) is in case the grain is too small it will go through the screen and give a high purity.

J. P. Foster, Maui Agricultural Co.:

(a)—No.

(b)—No.

(c)—Yes, we keep the basket hot by injecting steam into the space between the basket and its casing, and have found drying much facilitated with no apparent disadvantages.

(d)—No.

William Searby, Hawaiian Commercial & Sugar Co.:

(a)—Yes. (b)—Yes; resulted in local melting of the sugar. (c)—Yes. (d)—Yes.

P. W. Alston, Wailuku Sugar Co.:

We have tried mixing the massecuites with water, hot molasses, and with cold diluted molasses. All give the same result—quicker drying and increased purity of the final molasses. In each case the mixing was done at the pump that elevates the massecuite to the mixer.

A. Fries, Pioneer Mill Co.:

(a)—Mixing hot molasses with the massecuite as it is delivered into the centrifugals was tried here some three years ago; it improved the drying, but can be used only when the massecuite is not too heavy. This is with *our* machines where the end of the spout is too far away from the basket, and as the centrifugal must be in motion before it is charged, heavy massecuite will wind itself around the spindle and the operation is rather messy at times.

(b)—The method of warming the massecuite in the mixers by circulating hot water through a system of pipes was used last year, but discarded, as the resulting molasses was higher in purity. The time of drying was reduced up to 25%. The temperature of the massecuite, originally 30, was raised in portions to 32, 34, 36, and 40° C., and the molasses purity would rise with the increase in temperature 1, 2 and 3 points. The objectionable part of the method is that the massecuite does not get heated evenly and the part immediately surrounding the pipes is hottest and remains undisturbed and in contact with the hot pipe until the charging of a new machine brings the whole mass in motion again.

(c)—The method of blowing jets of steam into the centrifugals is used at present whenever the purging is too slow. The time of drying is cut down about 15% and the purity of the molasses is the same as when no steam is used. The jet of steam does not strike the basket and is turned on only for two-thirds of the time it takes to dry the sugar.

(d)—Diluting the massecuite with water or dilute molasses. Both methods have been used in the crystallizers; but we prefer to use water only. Heavy massecuite takes too much time for purging; it is necessary to dilute it although the purity of the

molasses is raised as much as 2½ points as is shown in the following table:

	Massecuite		Molasses		Days in Crystallizer	Increase in Purity
	Brix	Purity	Brix	Purity		
No water	98.0	55.0	96.7	30.3	6	
3.9% water	94.3	55.0	91.5	32.5	13	2.2
No water	96.8	55.4	94.5	31.8	10	
2.4% water	94.5	55.4	91.3	33.8	11	2.0
* 4.6% water	92.5	55.4	90.0	35.5	11	3.4
No water	96.5	56.0	93.0	30.2	12	
2.7% water	94.0	56.0	90.7	32.6	14	2.4
No water	95.3	54.0	93.2	31.9	20	
2.7% water	92.8	54.0	90.3	34.5	22	2.6
3.0% water	92.5	54.0	89.8	34.7	24	2.8
No water	95.3	55.7	94.5	32.2	Very sticky	
* Mol. of 65 Brix	93.0	55.7	90.3	35.4	11	3.2
3.5% water	92.0	55.7	88.8	35.8	12	3.6
No water	96.8	54.5	94.0	30.8		
2.9% water	94.0	54.5	89.5	33.2		2.4

* Where different amounts of water were applied to the same massecuite, two smaller crystallizers were filled from one boiling. Walker's separator was used with all massecuite.

A. Krafft, Oahu Sugar Co.:

(a)—This method greatly facilitates drying and improves the quality of the sugar, but it requires careful supervision as to proportions and temperatures; it is also liable to produce uncleanliness around the centrifugals.

(b)—I have not found much improvement from this method.

(c)—Ditto. It also shortens the life of the machines.

(d)—I have found the addition of water to be of benefit. It is added drop by drop to massecuites of 98° Brix after three days old. The addition is kept up until about 96° Brix is reached.

Geo. F. Renton Jr., Ewa Plantation Co.:

All of the centrifugals in which our low grades or No. 3 massecuites are dried, are supplied with steam which is delivered *between* the curb and basket (not *against* the basket). This keeps the basket and the massecuite next to the screen warm, resulting in a quicker drying sugar, a sugar with less adhering molasses (which reduces the return of low-grade molasses to subsequent boiling), and a sugar which does not cling to the screen, rendering it easy for discharge. The increase in purity of the resultant waste molasses is so small that it is negligible. We have tried mixing hot and cold molasses with the massecuite

before it is delivered into the centrifugals, and find that the centrifugals drying this mixture can deliver their charge quicker than any method we have yet tried, but the amount of sugar delivered per machine is so small that the time gained in drying it is more than lost by the small quantity of sugar delivered.

W. K. Orth, Koloa Sugar Co.:

(a)—We mix hot molasses with the massecuites as it is delivered into the centrifugals whenever we are pressed for time and room. This increases slightly the purity of the molasses. The method does not improve conditions if the massecuites dry slowly on account of false grain or very fine grain. If not done carefully it is liable to make things sloppy around the centrifugals.

(b)—Have not used this method.

(c)—Blowing jets of steam into the centrifugals always improves the drying, even with small amount of false grain or very fine grain in massecuites. It increases the purity of the molasses and is rather awkward and hot to use in small centrifugals. It is also hard on the baskets.

(d)—We always dilute massecuite with water to a density of about 94 to 95 Brix; even to a lower density if the massecuite is very viscous. We add a small quantity at a time, starting when massecuite has cooled and has become too stiff to be easily moved. The water must be added at least two days before drying. This method always improves drying and does not increase purity of final molasses if massecuite has been boiled to a high density, say 97 Brix or over. Dilute molasses has no advantage; water alone is cleaner.

A. B. Melancon, McBryde Sugar Co.:

I have a three-quarter inch pipe entering from the top of the centrifugals between the back and the lining, with 1/16 holes every inch. Before charging I heat the centrifugal, charge it, and then use just enough steam to keep it warm. This works satisfactorily, but if too much steam is used the purity of the molasses goes up.

The replies indicate a considerable difference of opinion as to which of these methods improves the drying of low-grade massecuites the most and with the least increase in purity of the molasses. When the slow drying is due to the presence of very small grain mixed with the larger grain, any attempt to improve the drying will increase the purity of the molasses by melting the small grain or allowing more of it to pass through the screen. But when the massecuite dries slowly on account of its high den-

sity the correct application of any of these methods, I believe, should result in an improvement in the drying, without any appreciable increase in the purity of the molasses. Personally, I prefer methods (c) and (d), using water in the latter in preference to dilute molasses.

As we make greater efforts to reduce the purity of our final molasses, this subject will become of increasing importance. Our recent investigations at the Experiment Station, on the production of exhausted molasses, indicate quite clearly that it will be necessary to boil the final massecuite to a higher density than has heretofore been the practice if we are to make much progress in this direction. In this case it will become necessary to adopt as a regular practice some method of treatment of the final massecuite before centrifugalling for the purpose of reducing the density of the molasses, in order to make possible its more rapid and complete separation from the sugar.

QUESTION 3: What have you found to be the principal causes for the slow drying of massecuites?

G. Giacometti, Olaa Sugar Co.:

False grain, first, last, and all the time!

Horace Johnson, C. Brewer & Co.:

The slow drying of low-grade massecuite is generally due to heavy concentration, very small and uneven grain, and to false grain.

To correct heavy concentration only, method (e) has been found to be most advantageous. With very small and uneven grain, dilution with molasses will help some, but if carried far enough to speed up the drying very much there is too much loss of small grain through the screens.

False grain in the strike will hinder drying more than any other cause. The false grain can be melted out by any of the methods outlined above, but all will cause a decided loss of sucrose.

I consider all the methods tried to be poor correctives to conditions which should be prevented rather than corrected.

John J. Muller, Pepeekeo Sugar Co.:

Speed of centrifugals has a lot to do with drying of low grade, as has viscosity and false grain.

E. T. Conant, Honomu Sugar Co.:

False grain is the principal cause for slow drying. The quality of the massecuite, and the purity of the molasses, also govern the time in which the crystal can be separated from the mother liquor.

K. W. Kinney, Hakalau Plantation Co.:

Besides the usual cause, to wit: false grain, I find that first massecuite is stubborn in drying if the mass is charged with first molasses of high glucose content.

In this case a sugar may appear very light, yet polarization will not equal that of a darker sugar obtained from a massecuite containing less glucose.

A massecuite of very even medium grain will not dry as well as one of a *very* uneven grain from medium up with a sprinkling of 10 total smalls. Centrifugal screen of 400 perforations to the square inch resists purging of medium-size grained massecuite to a marked extent.

J. M. Reynolds, Laupahoehoe Sugar Co.:

Slow drying, we believe, is caused by mixed grains and sticky molasses resulting from juices of low purity.

E. T. Westly, Paauhau Sugar Plantation Co.:

Boiled in heavy from too low purities, also when a too heavy boiled massecuite is cooled off too quickly.

J. E. Biela, Kohala Sugar Co.:

Low purity molasses if boiled at too high temperatures and cooled too rapidly—this is in my opinion the principal cause for slow drying of some massecuites; while the boiling to too high density of low purity molasses, is also a dominant factor in the drying of low-grade massecuites, as the grain is too small, from which the molasses separates with difficulty.

R. J. Richmond, Hawi Mill & Plantation Co.:

False grain, irregular grain (containing some very small though not false grain). Extreme viscosity of molasses sometimes caused by overheating in pans or by too much steam being used to heat before drawing into pan.

V. Marcallino, Hutchinson Sugar Plantation Co.:

(a)—Irregular grain.
(b)—Sticky or gummy molasses.

(c)—In case of low grades, boiling a mass of too low a purity to a high density.

Joseph Steinberg, Hawaiian Agricultural Co.:

The principal causes for slow drying of some massecuites are due mostly to different sizes of grain and the massecuites being boiled too heavy.

J. P. Foster, Maui Agricultural Co.:

False grain, excessively small, irregular grain, viscosity due to improper use of crystallizers.

Wm. Searby, Hawaiian Commercial & Sugar Co.:

Microscopic grain and high viscosities.

P. W. Alston, Wailuku Sugar Co.:

There are two main causes for the slow drying of massecuites —poor boiling, which yields a mixed grain with false grain, and viscous molasses.

A. Fries, Pioneer Mill Co.:

The principal causes for the slow drying of some massecuites are the density, irregular grain and the presence of very fine grain. Massecuites from low purity juices from canes which have deteriorated, are more liable to contain fine grain, and their gummy nature adds to the slow drying.

A. Krafft, Oahu Sugar Co.:

False grain, due to starting the strike with too small amount of seed-grain. The presence of air in the massecuite.

I have found that a low-grade massecuite, containing a great quantity of grain, boiled to a high density, free of air and properly aged, will dry well without any further treatment.

Geo. F. Renton, Jr., Ewa Plantation Co.:

The principal cause for the slow drying of some massecuites is the presence of small crystals of sugar, i. e., the whole strike may be made up of crystals that are very small, or a strike of larger crystals and false grain.

W. K. Orth, Koloa Sugar Co.:

Too low purity, too small a grain, too stiff massecuite. Low temperature is of less effect on well-boiled massecuite if purity is above 56, more retarding with lower purity.

There is almost complete unanimity in the replies to this question.

When the slow drying is due to very small and uneven-sized grain, I agree with Mr. Johnson that it should better be prevented rather than corrected.

QUESTION 4: Have you noticed any improvement in the drying of first massecuites due to making a larger-grained sugar?

G. Giacometti, Olaa Sugar Co.:

Certainly.

Horace Johnson, C. Brewer & Co.:

There has been considerable improvement in the speed with which the No. 1 sugar dries, due to a larger and more even grain.

H. F. Hadfield, Hilo Sugar Co.:

Yes.

H. D. Beveridge, Onomea Sugar Co.:

Owing to the limited pan capacity for first massecuites, we have not been able to improve the grain of our first sugar much.

John J. Muller, Pepeekeo Sugar Co.:

Large grain facilitates the drying of massecuites. Pepeekeo always had a fairly large grain, so we don't notice any difference from former years.

E. T. Conant, Honomu Sugar Co.:

A decided improvement.

K. W. Kinney, Hakalau Plantation Co.:

Yes.

J. M. Reynolds, Laupahoehoe Sugar Co.:

With large-grained sugar our massecuites dry much faster than with small grain.

E. T. Westly, Paauhau Sugar Plantation Co.:

Yes, we find that large-grained sugar dries much better.

J. E. Biela, Kohala Sugar Co.:

Large-grained sugars invariably dry better, and considerable saving of time is effected at the centrifugals.

R. J. Richmond, Hawi Mill & Plantation Co.:

Quite an improvement in centrifugalling No. 1 sugar since making the larger grain.

V. Marcallino, Hutchinson Sugar Plantation Co.:

A larger-grained sugar invariably dries better than a small or mixed-grained sugar.

Joseph Steinberg, Hawaiian Agricultural Co.:

A larger-grain sugar will improve the drying of the first massecuite.

J. P. Foster, Maui Agricultural Co.:

No.

William Searby, Hawaiian Commercial & Sugar Co.:

No.

P. W. Alston, Wailuku Sugar Co.:

Since making the large-grain sugars we have been able to transfer 50% of our first centrifugals to the low-grade work.

A. Fries, Pioneer Mill Co.:

The improvement in the drying of first massecuites due to a larger-grained sugar is very noticeable; 15-20% less screen area is required than with small-grained sugar.

A. Krafft, Oahu Sugar Co.:

The drying proceeds faster, and the capacity of the machines is increased.

Geo. F. Renton, Jr., Ewa Plantation Co.:

Decidedly so.

W. K. Orth, Koloa Sugar Co.:

First massecuite with large grain dries faster and better than small-grained material.

A. B. Melancon, McBryde Sugar Co.:

A large-grain sugar dries much better and is much easier to remove from centrifugal.

With two exceptions, all of the replies show that there has been a great improvement in the drying of first massecuites since larger-grained sugars have been produced.

QUESTION 5: Have you tried drying first massecuites without the use of any wash water, and if so what was the result?

G. Giacometti, Olaa Sugar Co.:

The sugar produced was less than 96 polarization.

Horace Johnson, C. Brewer & Co.:

Many of the C. Brewer & Co. mills use no water in drying their marketable sugars and are able to maintain a sugar of good quality.

H. F. Hadfield, Hilo Sugar Co.:

Yes. A straight strike, or a strike with little molasses, will dry better without water and with a correspondingly lower molasses.

H. D. Beveridge, Onomea Sugar Co.:

We don't wash any sugar in centrifugals.

John J. Muller, Pepeekeo Sugar Co.:

No water used except for washing spindles or when making store sugar.

K. W. Kinney, Hakalau Plantation Co.:

I find an increase in recovery of commercial sugar.

J. M. Reynolds, Laupahoehoe Sugar Co.:

We always use about a quart of water, sometimes two quarts to each centrifugal for washing.

E. T. Westly, Paauhau Sugar Plantation Company:

So far this year we have hardly used any wash water. We find when not using water that it gives us a very hard sugar to discharge if it is dried to about 1.00% moisture. Have there-

fore started to use a little water in the bottom of the centrifugal. It helps in digging it out all around the bottom; after that the rest is easy. We also find it hard to get 124 lbs. unwashed sugar into our bags if we try to do it right after it is dried. Leaving it in the bin for a few hours helps a lot. To make a 96 pol. unwashed sugar we have to boil an 80 apparent purity massecuite and the offrun is around 55 apparent purity. We have this year not used any low-grade sugar for seed.

J. E. Biela, Kohala Sugar Co.:

Drying first massecuites below 80° purity without water produces sugar which cakes very considerably when bagged from the centrifugals direct.

R. J. Richmond, Hawi Mill & Plantation Co.:

Have tried drying No. 1 massecuite with absolutely no water (purity about 81), and found it difficult to discharge from basket, the sugar being sticky and gummy on account of the viscosity of the molasses boiled in.

J. P. Foster, Maui Agricultural Co.:

We use wash water to bring up the polarization of an occasional strike which is lower than our shipping standard. It is used for this purpose only.

William Searby, Hawaiian Commercial & Sugar Co.:

Yes. Sugar does not cake in the bag and keeps better.

P. W. Alston, Wailuku Sugar Co.:

First massecuites should be boiled to yield the desired polarization without washing the sugar. But if the ash content of the sugar is too high, washing may be necessary in order to reduce it.

A. Fries, Pioneer Mill Co.:

With free-drying sugars no water is used. Sugars from very sticky massecuite need some water to handle them properly in the conveyors and elevators, also to facilitate the discharge from the bin to the automatic weighing machine. The higher the density of the massecuite, the greater the difficulty in handling these sticky sugars. The adhering highly concentrated molasses of low purity will hinder the complete discharge of the elevator buckets; some of the sugar will be carried back and will collect in the bottom of the elevator casing, where it is partly ground to powder,

causing the elevator to stop finally. By the slow discharge of the automatic weighing machine much time is lost. A sugar washed with about 1200 cc. water polarized 96.5; the same not washed, 94.8.

A. Krafft, Oahu Sugar Co.:

The sugar is voluminous and raises difficulties in the conveying, bagging and weighing process.

Geo. F. Renton, Jr., Ewa Plantation Co.:

With our system of sugar boiling, no water in the centrifugals gives a very sticky sugar and too low a polarization.

W. K. Orth, Koloa Sugar Co.:

We use no wash water if the purity of the massecuite is high enough to give sugar of 96 polarization. We use water to bring up to polarization. When using water it is generally easier to discharge the sugar, but increases the danger of having sugar not dry enough, especially if water is added too late.

A. B. Melancon, McBryde Sugar Co.:

In order to dry first massecuite without the use of water a good uniform grain and free sugar are required.

The practice of drying first sugars without washing is increasing. It is hardly possible, however, that it will be universally adopted. The stickiness of the unwashed sugar on some plantations may very probably be an inherent quality, depending on the composition of the juices.

QUESTION 6: What advantages and objections do you find to washing sugars in the centrifugals?

G. Giacometti, Olaa Sugar Co.:

Advantage, higher polarization; disadvantage, higher moisture.

Horace Johnson, C. Brewer & Co.:

Some of our mills wash the sugar in the centrifugals to a limited extent with the object of increasing the polarization and thus diminish the amount of ash in the sugar.

H. F. Hadfield, Hilo Sugar Co.:

Providing the water is pure and the amount used in washing can be controlled, there is no objection. There does not seem to be an improvement in the sugar when a mixture of warm molasses and water is used.

H. D. Beveridge, Onomea Sugar Co.:

Objections to washing sugars are: (1) Increased purity of molasses. (2) Injurious to the keeping qualities of sugars in storage, by removing the molasses coating, and the liability to inversion from injurious bacteria in wash water.

John J. Muller, Pepeekeo Sugar Co.:

Washing would bring up the polarization, but also raise purity of molasses and retard drying, since the moisture introduced through wash water will have to be taken out again.

E. T. Conant, Honomu Sugar Co.:

The use of water in the centrifugals helps to maintain a more constant polarization. Any errors made on the pan floor can be rectified to a certain extent by the use of water in the centrifugals.

K. W. Kinney, Hakalau Plantation Co.:

Recovery is lowered. Molasses increases in quantity and quality. Men get to abusing the use of water to the criminal negligence point.

J. M. Reynolds, Laupahoehoe Sugar Co.:

By using a small amount of water, drying is hastened and sugar polarization increased.

E. T. Westly, Paauhau Sugar Plantation Co.:

Would prefer not to wash at all, as I think the keeping quality of the sugar would be better; there would also be less water to evaporate in later boilings. We find 96 pol., unwashed sugar, of 1.00% moisture very hard to remove from the centrifugal, and it does not pack well in the bags.

J. E. Biela, Kohala Sugar Co.:

The use of water when drying first massecuites prevents, to some extent, caking in the bags, raises in some instances the

polarization, but it should be used with caution, as it raises the purity of the molasses, also with resulting decrease in the output of the first product.

R. J. Richmond, Hawi Mill & Plantation Co.:

We use a pint of water to a 40″ machine, partly to free the sugar and assist in emptying the basket and partly to wash spindle and discharge valve on the bottom of the basket. We have to wash our crystallizer grade of shipping sugar to bring it up to a suitable polarization.

V. Marcallino, Hutchinson Sugar Plantation Co.:

It is sometimes necessary to wash first sugar in order to bring same up to polarization. Further, washing removes the last coating of molasses, thereby rendering the sugar freer to discharge and less likely to attract moisture.

Joseph Steinberg, Hawaiian Agricultural Co.:

No objections, if the proper quantity of water is used.

J. P. Foster, Maui Agricultural Co.:

The advantage of washing is to raise the polarization, and the only disadvantage is the increased quantity and purity of the molasses.

William Searby, Hawaiian Commercial & Sugar Co.:

We have found no advantage in washing sugars in the centrifugals. The objection is that the water dilutes the film of molasses surrounding the crystals to a point favorable to fermentation, and unless care is taken to sterilize the water used for washing, the ferments are introduced with the wash water. A further objection to using wash water in the centrifugals is that the sugar cakes in the bags if it is stored for any length of time.

P. W. Alston, Wailuku Sugar Co.:

It may sometimes be necessary to wash the sugars in the centrifugals to obtain the proper polarization and ash content. This could be controlled by the purity of the massecuite, but the resulting molasses would be too high. The objections are the liability of infecting the sugars with destructive organism that will reduce the sucrose content of the sugar during shipment.

A. Fries, Pioneer Mill Co.:

Too much molasses adhering to the grain will absorb moisture very readily and for sticky sugars it is in my opinion of advantage to wash them, as they will not only dry faster and be easier handled, but will also keep better, provided they are thoroughly dried in the centrifugals. 500-1000 cc. of water are used whenever necessary, and the sugar is well dried, and we have no loss in polarization either at San Francisco or New York. The objections are a higher polarization when low polarizing sugars are desired, higher purity of molasses, and more water to evaporate.

A. Krafft, Oahu Sugar Co.:

If the sugar is washed too much, the keeping qualites are impaired. (See No. 5.)

Geo. F. Renton, Jr., Ewa Plantation Co.:

Advantages are free, clean sugar, not sticky, better keeping qualities, less spoiling or "sweating" during storage, cleaner centrifugal screens, easier and quicker drying and discharging.

Objection—Melting of sugar, but if sugar of large grain is manufactured, this objection becomes nil.

W. K. Orth, Koloa Sugar Co.:

Washing raises the polarization; if used in large quantities it may dissolve some of the objectionable fine grain. Objections as stated under 5 and liability of spilling with consequent untidiness.

A. B. Melancon, McBryde Sugar Co.:

The time to wash the sugar is just as the molasses leaves. If the sugar is hard to remove from the machine, a little water poured into the bottom of the machine before stopping will make it easier, but this will also increase the moisture.

Washing the sugar in the centrifugals assists to a certain extent the separation of the molasses from the sugar, which is the object of the centrifugalling. But it is also liable, if not carefully controlled, to dissolve some of the sugar and thus undo to some extent the previous process—the boiling. The principal objection, it seems to me, is the one pointed out most clearly by Mr. Searby, the danger of introducing fermenting organisms.

QUESTION 7: What have you found to be the best method of applying the wash water?

Horace Johnson, C. Brewer & Co.:

When required, the wash water can be best applied by a small hose attached to the main water supply and which has a spray nozzle on the end.

H. F. Hadfield, Hilo Sugar Co.:

The preserve tin often used is objectionable and unclean. A hose with a rosetop spray is as good as any, as it can be regulated fairly well and the same amount of water used in each load.

E. T. Conant, Honomu Sugar Co.:

We use a pint can.

K. W. Kinney, Hakalau Sugar Plantation Co.:

By spraying with a perforated rapid-opening nozzle.

J. M. Reynolds, Laupahoehoe Sugar Co.:

Have only tried pouring water on the spindle of centrifugals when drying process is about half done.

E. T. Westly, Paauhau Sugar Plantation Co.:

Have not tried any other method than applying it by hand from a tin.

J. E. Biela, Kohala Sugar Co.:

This question is difficult to answer adequately, as there is, at present, no contrivance in existence to gauge the quantity of water to be used, except the old reliable tin can of about 1 quart size, manipulated by the men at the centrifugals. When making sugars for domestic use, a spray, made preferably from centrifugal screen attached to a hose, is to be recommended, as this gives an evenly-washed sugar, instead of washed only in spots where the water strikes when applied with a tin can.

R. J. Richmond, Hawi Mill & Plantation Co.:

We have no special appliance for washing, but just use the old-fashioned can.

V. Marcallino, Hutchinson Sugar Plantation Co.:

Water is applied by means of small tins, so many tins to a machine. I believe that the best method would be to use a fine spray on the end of a hose, providing there is some device for measuring the amount of water for each charge.

Joseph Steinberg, Hawaiian Agricultural Co.:

By spray system.

J. P. Foster, Maui Agricultural Co.:

We use a cup.

Wm. Searby, Hawaiian Commercial & Sugar Co.:

We do not use wash water.

P. W. Alston, Wailuku Sugar Co.:

By hand.

A. Fries, Pioneer Mill Co.:

The use of a sprayer is in my opinion the best method for applying the water; it is more economical and the distribution is more even. Unless, however, the amount required can be measured for each machine, it is better to use cups, one or more cupfuls to be used, according to the massecuite. The water should be applied as soon as the inner layer of massecuite becomes dry and not towards the end of the purging, as these sugars show higher moisture content.

A. Krafft, Oahu Sugar Co.:

Immediately after the centrifugal is filled all the wash water should be applied. The purity of the molasses is not affected this way.

Geo. F. Renton, Jr., Ewa Plantation Co.:

Rubber hose and shower spray.

W. K. Orth, Koloa Sugar Co.:

Tins of equal size and containers that can be easily controlled and cleaned.

Automatic washing, with a spray, is being very generally adopted by the refineries. There is no reason why they should not do the work satisfactorily in raw sugar factories. There is still considerable room for mechanical improvement in the washers.

QUESTION 8: What is the source of the wash water which you use?

G. Giacometti, Olaa Sugar Co.:

Deep wells or rain water.

H. F. Hadfield, Hilo Sugar Co.:

Water from condensed steam.

John J. Muller, Pepeekeo Sugar Co.:

The water in house comes from reservoir supplied by flumes.

E. T. Conant, Honomu Sugar Co.:

Rain water.

K. W. Kinney, Hakalau Plantation Co.:

Condensates from effects.

J. M. Reynolds, Laupahoehoe Sugar Co.:

Spring water used.

E. T. Westly, Paauhau Sugar Plantation Co.:

Condenser water.

R. J. Richmond, Hawi Mill & Plantation Co.:

The water used for washing is flume water filtered through sand and stored in a small reservoir.

V. Marcallino, Hutchinson Sugar Plantation Co.:

Ordinary flume water. I realize that this is objectionable, but it is the best available.

Joseph Steinberg, Hawaiian Agricultural Co.:

Cold water.

J. P. Foster, Maui Agricultural Co.:

Calandria of last evaporator.

P. W. Alston, Wailuku Sugar Co.:

Condensate from the fourth cell of the evaporators.

A. Fries, Pioneer Mill Co.:

Fresh, clear mountain water; the containers are cleaned after every strike.

A. Krafft, Oahu Sugar Co.:

Artesian well water.

Geo. F. Renton, Jr., Ewa Plantation Co.:

Condensate from second and third bodies of the Lillie evaporator.

W. K. Orth, Koloa Sugar Co.:

Water from condensed steam.

A. B. Melancon, McBryde Sugar Co.:

We use water from our supply tank, but it is not satisfactory. At times I have tried condenser water from the pan. Next season I will use condensed water for washing the sugar.

The replies indicate that the necessity of using clean water at the centrifugals, to prevent deterioration of the sugar, is very generally recognized.

QUESTION 9*:* Do you remove the sugar from centrifugals by hand or with dischargers, and what advantages do you find in the method which you use over other methods?

G. Giacometti, Olaa Sugar Co.:

By hand.

Horace Johnson, C. Brewer & Co.:

When the battery of centrifugals consists of six or more centrifugals it is advantageous to use mechanical dischargers. There

is a definite saving in the number of men required, the quality of the labor need not be so good, and the capacity of the centrifugals is increased. With less than six centrifugals the saving is doubtful.

H. F. Hadfield, Hilo Sugar Co.:

By dischargers. It saves time.

H. D. Beveridge, Onomea Sugar Co.:

First sugar, by unloader; second sugar, by hand. On first sugars one man can do the work of two, with greater ease.

John J. Muller, Pepeekeo Sugar Co.:

The sugar from centrifugals is discharged by hand. We tried dischargers, but without any satisfaction.

E. T. Conant, Honomu Sugar Co.:

We discharge by hand.

K. W. Kinney, Hakalau Plantation Co.:

We remove sugar from centrifugals with Johnson plows. Although a rugged-looking apparatus, yet in these four years of its use here we have found it to be a very durable discharger and efficient. Being very easy of operation, the men take to them readily. Considering its first cost and the results obtained, I would venture to say that it has no peer in its line of duty.

J. M. Reynolds, Laupahoehoe Sugar Co.:

Sugar removed by hand only. No experience with dischargers

E. T. Westly, Paauhau Sugar Plantation Co.:

We remove the sugar by hand. Have had no experience with dischargers.

J. E. Biela, Kohala Sugar Co.:

We remove the sugar from the centrifugals by hand, and I am not in a position to express any opinion regarding the advantages or disadvantages of a discharger.

R. J. Richmond, Hawi Mill & Plantation Co.:

We have in use one mechanical discharger on our six 40″ machines and find it works very well with free sugar, but if sugar is sticky and packs hard in the basket we have to use the scoops to break it out. In a test made last year the time taken to discharge by the mechanical discharger was 18 seconds per machine less than the other machine. In the centrifugal with the mechanical discharger we have one of the American Tool Co.'s patent locking screens, which keeps in position with a smooth surface all the time.

V. Marcallino, Hutchinson Sugar Plantation Co.:

Sugar is removed by hand. I do not believe this method to be the most advantageous. Would prefer to use dischargers.

Joseph Steinberg, Hawaiian Agricultural Co.:

We remove the sugar by hand, and I find it to be of no advantage over the discharger.

J. P. Foster, Maui Agricultural Co.:

We use self-discharging centrifugals on first sugars; second sugar is discharged by hand.

Wm. Searby, Hawaiian Commercial & Sugar Co.:

We remove the sugar from the centrifugals by hand. We dry our sugars by contract, and though we have dischargers, the contractors prefer to use wooden paddles, and as they are very much easier on the screens than are the dischargers, and the contractors accomplish just as much work, we are satisfied.

P. W. Alston, Wailuku Sugar Co.:

Two men per shift dry 120 tons sugar per day, discharging by hand.

A. Fries, Pioneer Mill Co.:

By hand. The Gibson dischargers tried so far have not been satisfactory with sticky sugars. Mr. Daniels, the assistant engineer, has designed a discharger which marks a decided improvement. One of these has been in use for the past three months and is not only much easier to handle, but will discharge any sugar, no matter how sticky, and it will not damage the screens as much as the Gibson machines are apt to do.

A. Krafft, Oahu Sugar Co.:

By hand. I have found that the economy in labor by using dischargers is more than offset by the damage to the screens.

Geo. F. Renton, Jr., Ewa Plantation Co.:

Sugar removed with dischargers.

Increases the sugar discharged per machine because it discharges quicker and is easier on the operators; results in cleaner centrifugal screens and removes the objectionable feature of having wooden scrapers and damp wash cloth around centrifugals.

W. K. Orth, Koloa Sugar Co.:

We remove sugar by hand; have tried dischargers with poor success. In my opinion they are not suited to 30″ Weston machines; better on large machines. On the Hepworth type the discharger swings with the machine, not remaining stationary as in the Weston type.

A. B. Melancon, McBryde Sugar Co.:

We remove all sugar by hand. We have tried the Roberts-Gibson discharger, but it was not satisfactory.

The wide variation in experiences with mechanical dischargers shows that this is something which requires further investigation. Different quality of sugars could hardly account for all of it.

QUESTION 10: What type, size and speed of centrifugals have you found most satisfactory for different grades of massecuites?

Horace Johnson, C. Brewer & Co.:

The only experience I have had is with 30″ and 40″ centrifugals. Of the two, I prefer the 40″ centrifugals for all classes of work.

H. F. Hadfield, Hilo Sugar Co.:

Watson-Laidlaw 40″ machines. The objectionable heavy bell should, however, be replaced with a light one. 1100 to 1200 revolutions per minute for both grades of massecuite.

H. D. Beveridge, Onomea Sugar Co.:

At Onomea we have six 40″ Mackintosh belt-driven centrifugals with unloaders, handled by two men. These men are able to dry all first sugar and the centrifugals are idle half the time.

On second sugars we have eighteen 30″ belt-driven Weston centrifugals operated by two men, running full time, to handle low-grade sugars. These centrifugals are discharged by hand.

John J. Muller, Pepeekeo Sugar Co.:

We have dried commercial sugar as well as low grade in 30″ and 40″ machines. They both worked well.

E. T. Conant, Honomu Sugar Co.:

40″ belt-driven centrifugals running at 1000 R.P.M. for first sugar, and 30″ belt-driven centrifugals running at 1100 or 1200 R.P.M. for low grade.

K. W. Kinney, Hakalau Plantation Co.:

We find the American Tool Co.'s type of 40″ diameter x 24″ depth ball-bearing centrifugals driven at 1200 R.P.M. is a good all-around centrifugal.

J. M. Reynolds, Laupahoehoe Sugar Co.:

Have only 30″ centrifugals with speed of 1200 revolutions.

J. E. Biela, Kohala Sugar Co.:

I prefer large-sized (say 40″) machines for all grades of sugar, those for first massecuites running from 1200 to 1400 R.P.M., and those for lower grades from 1000 to 1200 R.P.M.

R. J. Richmond, Hawi Mill & Plantation Co.:

The 40″ with ball bearings, running about 950 R.P.M., for No. 1 sugars, and the 30″, making 1150 R.P.M., for low grade.

V. Marcallino, Hutchinson Sugar Plantation Co.:

Watson-Laidlaw 40″ machines, 1100-1200 R.P.M., are used for all grades, giving good satisfaction.

Joseph Steinberg, Hawaiian Agricultural Co.:

I find that the American Tool Co. 40″ and 1050 R.P.M. centrifugal is best for No. 1 sugar.

J. P. Foster, Maui Agricultural Co.:

For No. 1 sugar we use Watson, Laidlaw & Co. 48″x 30″ self-discharging machines; for No. 2 sugar we use 40″ machines; all water-driven.

Wm. Searby, Hawaiian Commercial & Sugar Co.:

We have two sizes of machines, 30″ and 40″. We have found the latter much more satisfactory than the former for all grades of massecuites and are of the opinion that larger machines could be used to advantage.

P. W. Alston, Wailuku Sugar Co.:

Belt-driven 40″ centrifugals of American Tool or Mackintosh.

A. Fries, Pioneer Mill Co.:

For first massecuite/ 40″ machines, 1000 R.P.M.; for second massecuite, 40″ machines, 900 R.P.M. The 40″ machines are to be preferred for low grades, as they save time and labor.

A. Krafft, Oahu Sugar Co.:

I have no preference as to type. For size I prefer 40″x24″; as speed, 1200 revolutions for first, and 1400 for second sugar.

Geo. F. Renton, Jr., Ewa Plantation Co.:

For any grade of sugar, 40″ machine, 1000 revolutions per minute, belt-driven from the back, *not overhead.*

W. K. Orth, Koloa Sugar Co.:

Having used 30″ and 40″ Weston centrifugals for both first and low-grade, I prefer the large machine as being more economical. Speed up to 1100 revolutions for the first massecuite, and 900 for second. I have not found the rigid spindle centrifugals of the Hepworth type well suited for low grades.

The preference for 40″ machines over the 30″ machines for all kinds of massecuites seems to be quite general.

The new 48″, self-discharging machines at Paia, referred to by Mr. Foster, are the most interesting of any recent installation of centrifugals. Their work will be watched closely by other plantations.

QUESTION 11: What weight of commercial and of low-grade sugar do you dry per man per hour?

G. Giacometti, Olaa Sugar Co.:

Commercial sugar, about 1½ to 2 tons; low grade, about ¼ ton.

H. F. Hadfield, Hilo Sugar Co.:

No. 1 sugar, 2 tons per man per hour; low-grade sugar, 2/10 ton per man per hour.

H. D. Beveridge, Onomea Sugar Co.:

First sugar, 5 to 6 tons dry sugar per man per hour; second sugar, no data.

John J. Muller, Pepeekeo Sugar Co.:

Commercial sugar, 2.4 tons per man per hour. Low grade depends on fast or slow drying.

E. T. Conant, Honomu Sugar Co.:

6000 lbs. of commercial sugar per man per hour, and 700 lbs. of low-grade sugar per man per hour.

K. W. Kinney, Hakalau Plantation Co.:

We dry an average of 4 tons of commercial sugar per man per hour. Of low grade, about 250 lbs. per man per hour.

J. M. Reynolds, Laupahoehoe Sugar Co.:

Sugar dried per hour man: 1750 lbs. commercial sugar, 660 lbs. No. 2 sugar, 160 lbs. No. 3 sugar.

E. T. Westly, Paauhau Sugar Plantation Co.:

2½ tons of commercial sugar per man per hour; ½ ton of low grade per man per hour. (We have two grades of low grade. The first grade dries at the rate of about 1¼ tons per man per hour, and the second grade at the rate of about ¼.)

J. E. Biela, Kohala Sugar Co.:

We dry 1.25 tons of commercial sugar per man per hour. I have no figures for drying low-grade massecuites, of which the drying depends on the quality of the different material.

R. J. Richmond, Hawi Mill & Plantation Co.:

About 1¼ tons per man per hour. This is averaging first massecuite dried direct from pan with crystallizer shipping sugar cooled in motion during three or four days.

V. Marcallino, Hutchinson Sugar Plantation Co.:

Weight of commercial sugar dried per man per hour, about 2½ tons. Low grade, no data.

Joseph Steinberg, Hawaiian Agricultural Co.:

We dry from 2 to 2½ tons per man of commercial sugar per hour and about 550 lbs. of low grade per man per hour.

J. P. Foster, Maui Agricultural Co.:

First sugar, 4 to 4½ tons per man per hour; second sugar, have no record—two men dry all the low grade.

Wm. Searby, Hawaiian/Commercial & Sugar Co.:

Commercial sugar, 3½ to 4 tons per man per hour, depending on the amount of massecuite coming along. When the mills are working at full capacity the average for a week has exceeded 4½ tons per man per hour. No. 2 sugar, 2 tons per man per hour.

P. W. Alston, Wailuku Sugar Co.:

2.89 tons first sugar per hour per man is the actual average for a six-weeks period. The highest average for one week was 3.22. For drying second massecuites we found an average of 26 cu, ft. per man per hour for the same period.

A. Fries, Pioneer Mill Co.:

Commercial sugar, 2.5 tons per man per hour; low-grade sugar, 0.3 ton per man per hour.

Geo. F. Renton, Jr., Ewa Plantation Co.:

No. 1 sugar, about 3½ tons per man per hour; No. 2 sugar, about ¾ ton per man per hour; No. 3 sugar, about ⅓ ton per man per hour.

A. Krafft, Oahu Sugar Co.:

2600 lbs. of first sugar and 800 low grade.

W. K. Orth, Koloa Sugar Co.:

Commercial sugar in 40″ Hepworth machine, 1.68 tons per man per hour and more; low grades in 30″ Weston, 0.229-0.42 ton per man per hour.

These replies indicate a great difference in the output of sugar, per machine and per man, in the different factories. This may be due to a certain extent to the character of massecuites and the composition of the juices, but the probability is that it is not due altogether to this. It is worth looking into, especially by those plantations drying less than two tons of commercial sugar per man per hour.

QUESTION 12: What method of conveying the sugar away from the centrifugals have you found most satisfactory?

G. Giacometti, Olaa Sugar Co.:

Belt conveyors.

Horace Johnson, C. Brewer & Co.:

For marketable sugars the most satisfactory carrier for general conditions is the drag slat carrier. There is less chance of breakage of the carrier and less breaking of crystals, which occurs especially with the scroll conveyors.

For the low-grade sugar I do not know of any conveyor which is satisfactory. The best method to handle this product is to drop it into a mixer extending under the entire battery of centrifugals, where it can either be melted or mixed into a seed magma.

H. F. Hadfield, Hilo Sugar Co.:

Grasshopper conveyor.

H. D. Beveridge, Onomea Sugar Co.:

Think the slat conveyor superior to the worm, as it crushes less grain. No experience with grasshopper conveyor.

John J. Muller, Pepeekeo Sugar Co.:

We have used grasshopper and slat conveyors; both worked well.

E. T. Conant, Honomu Sugar Co.:

Having only four centrifugals for our first sugar, we use chutes to convey the sugar from the centrifugal to the elevator. We find that the angle limit at which these chutes will carry the sugar, unaided, is 40 degrees.

K. W. Kinney, Hakalau Plantation Co.:

Grasshopper for No. 1 sugar and slat conveyor for low grades if mechanical conveyor must be used; but I prefer to make such arrangements under No. 1 centrifugals so that sugar can be chuted down into a common receptacle and from there elevated with bucket elevator or gravitated into sugar scale bins.

J. M. Reynolds, Laupahoehoe Sugar Co.:

Screw conveyor.

E. T. Westly, Paauhau Sugar Plantation Co.:

Have only had experience with grasshopper conveyors. Like them very much on the shipping sugar but not on the low grade, as it has a tendency to stick.

J. E. Biela, Kohala Sugar Co.:

I have had experience with the scroll conveyor only, and will say that I am not enthusiastic over that contrivance. A considerable percentage of the small grain found in sugars from factories employing this type of conveyor is due to the crushing properties of this arrangement.

R. J. Richmond, Hawi Mill & Plantation Co.:

We are using the grasshopper conveyor driven by motor, and it works very satisfactorily provided the current is strong enough to keep it at a certain speed, otherwise the sugar hangs and will not travel. We expect to change the drive in the near future to a belt from an engine shaft.

V. Marcallino, Hutchinson Sugar Plantation Co.:

A slat conveyor is used, giving no trouble.

Joseph Steinberg, Hawaiian Agricultural Co.:

A scroll conveyor.

J. P. Foster, Maui Agricultural Co.:

A scroll conveyor.

Wm. Searby, Hawaiian Commercial & Sugar Co.:

Belt conveyor for first sugars.

P. W. Alston, Wailuku Sugar Co.:

Grasshopper or drag for shipping sugars. For second sugar that is to be remelted or used for seed there should be no conveyor.

A. Fries, Pioneer Mill Co.:

Screw conveyors and bucket elevators are used here; we have no experience with other models.

A. Krafft, Oahu Sugar Co.:

I have used scroll and grasshopper conveyors, but I believe that belt conveyors would best answer the purpose.

Geo. F. Renton, Jr., Ewa Plantation Co.:

Grasshopper conveyor for commercial sugar; screw conveyor for low-grade sugar.

W. K. Orth, Koloa Sugar Co.:

We find a screw or scroll conveyor satisfactory, being of simple mechanism and efficient.

A. B. Melancon, McBryde Sugar Co.:

We use a scroll conveyor for all sugars.

QUESTION 13: What effect, if any, has the conveyor on the sugar?

H. F. Hadfield, Hilo Sugar Co.:

Some of the grain gets crushed.

H. D. Beveridge, Onomea Sugar Co.:

Breaks up a portion of the grain, especially the worm conveyor.

John J. Muller, Pepeekeo Sugar Co.:

Neither the grasshopper nor slat conveyor has any effect whatever on the sugar.

J. M. Reynolds, Laupahoehoe Sugar Co.:

The conveyor has apparently no effect on the sugar.

E. T. Westly, Paauhau Sugar Plantation Co.:

Don't think the grasshopper conveyors have much effect on the sugar, but the bucket conveyors that take it up to the sugar bin crush a lot of the crystals into a flour.

R. J. Richmond, Hawi Mill & Plantation Co.:

I cannot see that our grasshopper conveyor has any effect on the grain of the sugar by powdering or otherwise.

V. Marcallino, Hutchinson Sugar Plantation Co.:

Undoubtedly the grain is broken to a certain extent, due to the dragging of the sugar along the bottom of the conveyor. I do not believe, however, that enough damage is done to warrant the discarding of this type of conveyor.

Joseph Steinberg, Hawaiian Agricultural Co.:

The sugar is mixed by using the scroll method.

Wm. Searby, Hawaiian Commercial & Sugar Co.:

None.

P. W. Alston, Wailuku Sugar Co.:

None.

A. Fries, Pioneer Mill Co.:

There is no breaking up of grain; the sugar is thoroughly mixed by the time it reaches the bin.

A. Krafft, Oahu Sugar Co.:

Drag as well as scroll conveyors are liable to crush the crystals.

Geo. F. Renton, Jr., Ewa Plantation Co.:

No effect on commercial. Helps to melt low-grade sugar.

W. K. Orth, Koloa Sugar Co.:

I do not find that it grinds the sugar. Perhaps a very thin layer between the screw and body of the conveyor, which layer remains after once established. A belt conveyor was hard to keep cleaned and was unsatisfactory.

In the beginning of our campaign for the improvement of the refining value of our sugar, some of the blame for the fine grain was laid at the door of the screw conveyor. This form of conveyor and also the drag conveyor undoubtedly do grind up some of the grain. But I believe the amount is very small—considerably less than 1% by weight.

QUESTION 14: Do you use any method of mixing or cooling the sugar. Describe in detail.

G. Giacometti, Olaa Sugar Co.:

We pass the sugar through a Hersey drier, without steam.

H. F. Hadfield, Hilo Sugar Co.:

A revolving disc with angle irons on its face over a 10″ pipe leading from the outside bottom of the sugar bin tends to break the lumps and cool the sugar.

E. T. Westly, Paauhau Sugar Plantation Co.:

The sugar after leaving the centrifugals drops down a couple of feet onto a grasshopper conveyor. Leaving same it drops into the bucket conveyor and is taken up about 35 feet into the sugar-bin. As the sugar drops from the buckets it hits a rapidly-revolving circular iron plate, which is studded with ⅜ x 4″ iron fingers. This plate breaks up any lumps and throws the sugar against the side of the bin.

R. J. Richmond, Hawi Mill & Plantation Co.:

We elevate our sugar from the machines and discharge it into the bin of about 100 bags capacity. This mixes it and cools it slightly. From the bottom of the bin the sugar discharges to another elevator which delivers it to the automatic scale.

Joseph Steinberg, Hawaiian Agricultural Co.:

We have no special device for mixing the sugar; it is cooled a short time before being put into the bags.

Wm. Scarby, Hawaiian Commercial & Sugar Co.:

Yes. We use Hersey dryers. We run the fans on the dryers but not the radiators.

P. W. Alston, Wailuku Sugar Co.:

Sugar delivered on a revolving plate in the top of the bin. The centrifugal force throws the sugar in a spray against the sides of the bin. In this manner it is cooled and mixed.

A. Fries, Pioneer Mill Co.:

As the sugar is delivered into the bin it strikes the revolving table and is thrown in a spray against the sides of the bin. This cools the sugar to a certain extent.

Geo. F. Renton, Jr., Ewa Plantation Co.:

Commercial sugar is mixed and cooled in Hersey dryers without steam.

A. B. Melancon, McBryde Sugar Co.:

Our sugar is elevated to a bin by a link-belt elevator.

There is undoubtedly some advantage in cooling the sugar before packing. More sugar can generally be put into the bag, and it has less tendency to cake. The Hersey drier, as it is used at Olaa, Puunene and Ewa, cools and mixes the sugar very satisfactorily, but it is an expensive machine, both in installation and operation, for this purpose.

QUESTION 15: What have you found to be the source of the dark-colored lumps in the sugar and the best method of removing them?

G. Giacometti, Olaa Sugar Co.:

Burning on coils.

H. F. Hadfield, Hilo Sugar Co.:

If the steam coil is open and not covered by the massecuite in the pan, the splashing massecuite will burn on the coil and cause dark-colored lumps in the sugar. Steaming out the pan too long will burn the sugar on the coils, and the burned lumps will mix with the next strike. There is no method of removing them that I know of.

H. D. Beveridge, Onomea Sugar Co.:

(a) Pan not properly steamed out before starting strike.
(b) Insufficient mixing of sugar and syrup in seed mixer.
(c) Poor pan circulation.
(d) Improper mixing syrup or molasses with massecuite in pan when charging. Poor pan work.

John J. Muller, Pepeekeo Sugar Co.:

Dark lumps are mostly found in the pan when the circulation is poor, causing the massecuite to stick to the coils.

E. T. Conant, Honomu Sugar Co.:

Our sugar is practically free from dark lumps.

K. W. Kinney, Hakalau Plantation Co.:

I have never had trouble with dark seed or dark lumps, therefore am not capable of making suggestions as to how it is caused and how to eradicate the trouble.

J. M. Reynolds, Laupahoehoe Sugar Co.:

Believe dark lumps in sugar are caused by poor circulation in the pan. Some juices, not boiling as freely as others, become burnt near the coils.

E. T. Westly, Paauhau Sugar Plantation Co.:

Burnt massecuite and old (dry) massecuite from chutes and mixers. Do not let them form. Steam out the pans well and have the steaming-out pipes so arranged that they will be away over the level of massecuite when boiling. Clean out the chutes and mixers well after each strike.

J. E. Biela, Kohala Sugar Co.:

I have noticed that dark-colored lumps appear mostly in sugar from coil pans and are due, in my opinion, to premature turning on of steam in the coil before it is sufficiently covered with juice.

R. J. Richmond, Hawi Mill & Plantation Co.:

Dark-colored lumps (burnt sugar and caramel) are caused in greater part by either leaky steam valves, opening steam on coil before they are properly covered, or by faulty construction of inlets to calandrias and coils. These inlets are placed too high in some pans, so that when the steam is opened into the coils or calandrias, although the level of the massecuite may be above the heating surface, there is a considerable area of the entering steam pipe uncovered, which until covered by the boiling massecuite is being gradually spattered with drops of the massecuite, which get burnt on, and when the pan is discharged, they appear as burnt lumps. The circulating device, consisting of a series of rings or bands fastened together, and forming a double shell to the pan, is also a burnt sugar collector. We have at present no special means of screening these out from the sugar except to pick them out by hand.

V. Marcallino, Hutchinson Sugar Plantation Co.:

Probably caused by sticking to coil or calandria and burning, while pan is shut down. Small quantities of massecuite left behind after discharging a strike, might be partly changed to caramel before starting the next strike. We are using no method for removing these lumps.

Joseph Steinberg, Hawaiian Agricultural Co.:

I find the centrifugal screens, when they get plugged, to be the cause of dark-colored lumps in the sugar.

J. P. Foster, Maui Agricultural Co.:

We find them only in the discharge from coil pans, and believe them to be due to encrustations on coils.

Wm. Searby, Hawaiian Commercial & Sugar Co.:

The principal source of dark-colored lumps is the sugar concretions that form on the coil clamps and supports. The best method of removing them is by screening them out.

P. W. Alston, Wailuku Sugar Co.:

Dark-colored lumps are due to small amounts of sugar collecting on parts of the centrifugals and conveyors and sticking there until dislodged, when they fall into the sugar. Frequent and thorough cleaning around these stations will reduce this trouble.

A. Fries, Pioneer Mill Co.:

We have no dark-colored lumps.

A. Krafft, Oahu Sugar Co.:

If the centrifugal screens overlap too much. Also burning of massecuite on coils of pans.

Geo. F. Renton, Jr., Ewa Plantation Co.

The last centrifugal full of No. 1 massecuite from every "strike" obtained by scraping the mixer does not dry well throughout, especially at that portion of the centrifugal where the screen laps. On emptying the centrifugals with dischargers we obtain a sugar which is well mixed with lumps of massecuite as undried sugar, which is removed from the good sugar by screening. This is accomplished by stretching wires from one

end of the grasshopper conveyor to the other, supported at intervals with angle iron, but *without any cross wires.* This makes a double-decked conveyor working as one machine, the sugar traveling along the conveyor to the bucket elevator, the lumps traveling along the stretched wires above to an open bag at the discharge end.

W. K. Orth, Koloa Sugar Co.:

The source of dark lumps is poor circulation in the pan, or if they appear occasionally, a leak—may be very slight—in the steam coil or drum. I do not know of a method of removing them. I have tried to screen them out; the screen, however, if of small enough mesh to catch the lumps, clogs up in a very short time and retains such a large amount of sugar that it becomes impracticable. Mechanical hammers do not keep the screens cleaned.

A. B. Melancon, McBryde Sugar Co.:

The chief cause for dark lumps is seeding with molasses grain. It is impossible to make a brilliant grain of a dark molasses. If I mistake not I think it was at our last meeting that Dr. Norris read to us the complaint about Hawaiian sugars that had been seeded with low-grade sugar. He said we had to discard this method of seeding. To my recollection we all agreed to this. The pan capacity in nearly every mill has been increased, but how many have discarded the seeding with low grade? On the contrary, there are more than ever.

More attention should be paid, I believe, to preventing the formation or to the removal of the dark lumps in the sugar. From a refining value standpoint they detract, sometimes very seriously, from the good qualities which the sugar may otherwise have. If not too small they can usually be readily screened out of the dry sugar, and it is worth while doing this if there are more than two to three lumps per bag. But efforts should also be made to overcome the trouble at the other end; that is, preventing their formation.

QUESTION 16: Do you store the sugar before bagging, and for what purpose?

Horace Johnson, C. Brewer & Co.:

Many of the sugar rooms are equipped with a storage bin of 15 to 20 tons sugar capacity. These bins have a rotating disc at the top, upon which the sugar falls as it enters the bin. The sugar is thrown against the side of the bin, the lumps are broken up, and a certain amount of cooling takes place. The large capacity of the bin not only allows a certain amount of cooling to take place, but it also allows the sugar to be economically and conveniently bagged.

K. W. Kinney, Hakalau Plantation Co.:

No, we do not store sugar before bagging, but have had experience with storing up sugar in a large bin and bagging it when cooled off, and found the bags did not cake.

E. T. Westly, Paauhau Sugar Plantation Co.:

We keep it sometimes a few hours in the sugar bin before bagging so as to be able to get 124 lbs. into a bag.

R. J. Richmond, Hawi Mill & Plantation Co.:

We store sugar in the bin in order to mix and cool it, and also, in case anything happens to the bagging and sewing machinery, the centrifugals may still keep running while repairs are made.

V. Marcallino, Hutchinson Sugar Plantation Co.:

Sugar is not stored before bagging unless we happen to be short of cars.

Joseph Steinberg, Hawaiian Agricultural Co.:

We store our sugar a short time so as to bag it more steadily.

P. W. Alston, Wailuku Sugar Co.:

The sugar is delivered into a bin above the weighing and bagging station. This assists in cooling the sugar and gives a flexible station. It is not necessary to stop the machines if there is a delay at the bagging and weighing station.

A. Fries, Pioneer Mill Co.:

A bin, holding 50 tons of sugar, gives a continuous supply for

the men bagging it; it also cools the sugar. Warm sugar takes more space in the bags and does not run so freely into the automatic machine.

Geo. F. Renton, Jr., Ewa Plantation Co.:

Yes, system of drying and bagging becomes more flexible. These two departments are independent of each other while working or during a breakdown in either station. Also, an even stream of sugar can thus be delivered to the automatic scales, giving more uniform weights.

W. K. Orth, Koloa Sugar Co.:

We store sugar to save labor.

A. B. Melancon, McBryde Sugar Co.:

Our sugar is bagged direct from the centrifugals.

Some storage capacity for the sugar between the centrifugals and the bags is advantageous, both for cooling the sugar and giving some leeway at the packing station. It is worthy of more general adoption.

QUESTION 17: Is your sugar weighed by hand or with an automatic scale, and what advantages have you found in your method?

G. Giacometti, Olaa Sugar Co.:

By hand.

Horace Johnson, C. Brewer & Co.:

The sugar is weighed by either Richardson automatic scales or on small platform scales. With proper attention the automatic scale gives just as satisfactory results as the platform scale.

H. F. Hadfield, Hilo Sugar Co.:

Automatic scale.

H. D. Beveridge, Onomea Sugar Co.:

Hand weighed. Automatic scales not accurate for weighing hot, sticky first sugar.

John J. Muller, Pepeekeo Sugar Co.:

Sugars are weighed by hand. Never having tried an automatic scale, cannot discuss advantages or disadvantages.

E. T. Conant, Honomu Sugar Co.:

By hand. More accurate weights.

K. W. Kinney, Hakalau Plantation Co.:

We weigh with a Richardson automatic scale. Automatic weighing saves labor, and is just as accurate as weighing by hand. One man has weighed with this scale 96 tons of sugar in 12 hours. With an ordinary beam scale this would have required at least three men.

J. M. Reynolds, Laupahoehoe Sugar Co.:

Sugar weighed by hand. Preferred to automatic scaling.

E. T. Westly, Paauhau Sugar Plantation Co.:

We weigh by hand, and have had no experience with automatic sugar scales.

J. E. Biela, Kohala Sugar Co.:

Our bags are weighed by hand, and I prefer that method, for accurate weights, to that of automatic weighing with the scales at present in use.

R. J. Richmond, Hawi Mill & Plantation Co.:

We have in use a Richardson automatic scale for the sugar, but find that with our generally more or less sticky sugar the weights vary, and although we use it, every bag is also placed on the platform scale and corrected.

V. Marcallino, Hutchinson Sugar Plantation Co.:

Sugar is weighed by hand. Have no objection to automatic weighing, as long as the scale is in good working order.

Joseph Steinberg, Hawaiian Agricultural Co.:

We weigh our sugar by hand.

J. P. Foster, Maui Agricultural Co.:

Automatic scale; cheaper.

Wm. Searby, Hawaiian Commercial & Sugar Co.:

Our sugar is weighed by hand, and check weighed. We find this method more accurate than using automatic scales.

P. W. Alston, Wailuku Sugar Co.:

An automatic scale is used to fill the bags, but the weight is made up and corrected on a platform scale.

A. Fries, Pioneer Mill Co.:

Automatic scale; saving of labor and quicker handling.

A. Krafft, Oahu Sugar Co.:

With automatic scales. This is cleaner and more economical than weighing by hand. With proper attention the weights are fairly accurate.

Geo. F. Renton, Jr., Ewa Plantation Co.:

Automatic scales; quicker and easier on the men, and results good, as stated above.

W. K. Orth, Koloa Sugar Co.:

Sugar is weighed with an automatic scale. This is a saving in labor and is accurate, if scale is not worked too fast and is kept in good condition. Two scales should be employed if a large quantity of sugar is to be weighed. If scale is worked too rapidly and the operator has little time to check and adjust it, the weighing will probably be inaccurate. Our scale has been used for seven years with entire satisfaction to us.

A. B. Melancon, McBryde Sugar Co.:

Our sugar is weighed by automatic scale satisfactorily.

The replies indicate a wide variation in experience with automatic sugar scales. This is due, probably, mainly to the condition of the sugar. If the sugar is sticky the automatic scale will not handle it as readily as if free. Allowing the sugar to cool will make it more free.

QUESTION 18: What is the inside length and width of the bag, and how many pounds of sugar do you put into it?

G. Giacometti, Olaa Sugar Co.:

Size 22″x 36″; weight 125 lbs.

Horace Johnson, C. Brewer & Co.:

The bags are unhemmed and measure inside from 21″ to 22½″ in width, and from 35″ to 38″ deep. Some of the bags are so short and narrow that it is impossible to get in 124 lbs. of sugar and sew with the machine.

H. F. Hadfield, Hilo Sugar Co.:

Inside measurement 22″x 36″; weight 124 lbs.

H. D. Beveridge, Onomea Sugar Co.:

Bags—Inside length, 35″-36″; width, 22½″-23″. 125 lbs. of sugar per bag.

John J. Muller, Pepeekeo Sugar Co.:

The inside length of bags is 38″; width, 22½″. 125 lbs. of sugar is put into the bag.

E. T. Conant, Honomú Sugar Co.:

23″x 38″; 125 lbs.

K. W. Kinney, Hakalau Plantation Co.:

Length, 38″; width, 22½″. 124 lbs. sugar.

J. M. Reynolds, Laupahoehoe Sugar Co.:

Bags 22″x 35″; 125 lbs. sugar.

E. T. Westly, Paauhau Sugar Co.:

The usual size is 37″x 22″, but we have them as small as 35½″ x 21¾, and a few freaks that would only hold about 75 lbs. We put 124 lbs. of sugar into each bag.

J. E. Biela, Kohala Sugar Co.:

We put 125 lbs. of sugar in bags 36″ long, 22″ wide.

R. J. Richmond, Hawi Mill & Plantation Co.:

37½″x 22″. 125 lbs. to a bag.

V. Marcallino, Hutchinson Sugar Plantation Co.:

Bags 35″x 22″. 124 lbs. sugar per bag.

Joseph Steinberg, Hawaiian Agricultural Co.:

The inside width and length of our bags is 22 by 37½. We put 125 lbs. of sugar in a bag.

J. P. Foster, Maui Agricultural Co.:

22″x 36″; 125 lbs.

Wm. Searby, Hawaiian Commercial & Sugar Co.:

21″x 36″. We put 125 lbs. net in each bag.

P. W. Alston, Wailuku Sugar Co.:

22″x 38″; 125 lbs.

A. Fries, Pioneer Mill Co.:

Inside size of bags, 38″x 22½″ and 40″x 21½″, according to the width of the cloth, which measures between 44 and 46 inches.

A. Krafft, Oahu Sugar Co.:

The size of the sugar bags is 21½″x 36″. They hold 125 lbs. of sugar.

Geo. F. Renton, Jr., Ewa Plantation Co.:

Length, 37″; width, 22″. 130 lbs. sugar in a bag.

W. K. Orth, Koloa Sugar Co.:

Cotton bags, 22¾″x 36″; jute bags, 22″x 39″. 125 lbs. to a bag.

A. B. Melancon, McBryde Sugar Co.:

Inside measurement of bags, 22″x 36″. The scale is set at 126 lbs. The bags weigh 1 lb. each.

QUESTION 19: Do you make your own bags, and if so what advantages have you found in doing so?

Horace Johnson, C. Brewer & Co.:

None of the bags used at the C. Brewer mills are made at the mills. The bags used this year are very poor quality and break easily in handling.

(This reply covers the following mills on our list: Hilo Sugar

Co., Onomea Sugar Co., Pepeekeo Sugar Co., Honomu Sugar Co., Hakalau Plantation Co., Paauhau Sugar Plantation Co., Hutchinson Sugar Plantation Co., Hawaiian Agricultural Co., and Wailuku Sugar Co.)

R. J. Richmond, Hawi Mill & Plantation Co.:

During the 1917 crop we made our own bags, but owing to having had an order placed some time previously for Indian bags we have discontinued making them this season. The advantages in making our own bags were that we could make them slightly cheaper and also that we had a standardized bag which did not vary in size, whereas the Calcutta bags are often of odd sizes, badly cut, and small.

J. P. Foster, Maui Agricultural Co.:

Yes, very much cheaper and better bags.

A. Fries, Pioneer Mill Co.:

Advantage in making bags at the factory: They can be made the proper size to suit the sugar, also sewing is better than with the ready-made bags.

A. Krafft, Oahu Sugar Co.:

The making of bags was discontinued owing to war conditions. Previously it was found to be cheaper than to buy ready-made bags.

W. K. Orth, Koloa Sugar Co.:

We make our own bags because we can suit size to our own wishes.

A. B. Melancon, McBryde Sugar Co.:

Our bags are made by the Hawaiian Sugar Co.

It is probable that after the war is over the making of bags from jute cloth on the plantations will be extended. The experience of all plantations that have tried this has been satisfactory.

QUESTION 20: Have you had any difficulty sewing the filled bags by machine, and do you use any special methods to aid in the sewing?

K. W. Kinney, Hakalau Plantation Co.:

Sometimes when the sugar is heavily coated with molasses and the grains are large it doesn't pack well enough to allow of sufficient margin for sewing the bags. In that case extra tamping is resorted to with a special tamping appliance, and the scale conveyor is lowered to allow the bags being run through and sewed.

J. M. Reynolds, Laupahoehoe Sugar Co.:

Our bags are sewed very satisfactorily by machine.

E. T. Westly, Paauhau Sugar Co.:

Only when we have green men on the job.

J. E. Biela, Kohala Sugar Co.:

We sew the bags by hand.

R. J. Richmond, Hawi Mill & Plantation Co.:

We have no difficulty in sewing by machine. For the past two seasons we have been turning in the tops of the bags before running through the sewing machine, and now have no complaints about bags opening up at the mouth when shipping at Mahukona.

Geo. F. Renton, Jr., Ewa Plantation Co.:

An extra man is on hand to shake the sugar down into the bag when necessary to make it possible to sew up the bags correctly, that is, far enough away from the end or edge of the bag to prevent ripping or the pulling away of the stitching of bag.

QUESTION 21: How do you sample commercial sugar? If the method is new, give details.

H. F. Hadfield, Hilo Sugar Co.:

A small box on the side of the bin receives the sugar, a little at a time, from the sugar flying off the revolving disc and collects where it is removed every strike.

H. D. Beveridge, Onomea Sugar Co.:

A small sample taken from every fourth bag at scales and stored in a closed container.

E. T. Conant, Honomu Sugar Co.:

A pinch out of every four or five bags.

K. W. Kinney, Hakalau Sugar Plantation Co.:

In five years' time we have tried out three methods of sampling sugar and the method now in practice throughout this season as suggested by Mr. Elliott, the chemist, we think is the most improved. A pipe is put through that side of the sugar bin opposite the emptying buckets, so placed that from every bucketful dumped against the side of bin some of the sugar trickles down through the pipe to a locked receptacle. The sampling device is so far away from men's paths and stands out in such a conspicuous position that it is almost an impossibility for it to be tampered with. The sampling is continuous and the result representative.

J. M. Reynolds, Laupahoehoe Sugar Co.:

Commercial sugar is sampled by taking one portion at the bagging machine, after the strike is about one-fourth dried. It is immediately polarized.

E. T. Westly, Paauhau Sugar Plantation Co.:

A few grams are taken from each bag before sewed.

J. E. Biela, Kohala Sugar Co.:

I have three inverted sample bottles placed in a rack on the scale and about a teaspoonful from every bag is put into a bottle and the bottles are replaced with empties when filled. I take six of such bottles from a day's run, about 48 oz. from 35 to 40 tons of sugar.

R. J. Richmond, Hawi Mill & Plantation Co.:

Have no special sampling apparatus; simply take out a portion from every tenth bag filled.

V. Marcallino, Hutchinson Sugar Plantation Co.:

An ordinary sugar sampler is driven into the top of every tenth bag before sewing.

Joseph Steinberg, Hawaiian Agricultural Co.:

The commercial sugar is sampled by a ¾″ brass pipe at the end of the sugar bin where the sugar enters the bags; it gives a good composite sample.

J. P. Foster, Maui Agricultural Co.:

An occasional sample is taken from the filled bag before closing.

Wm. Searby, Hawaiian Commercial & Sugar Co.:

We draw a continuous sample from the bagging chute into an airtight container.

P. W. Alston, Wailuku Sugar Co.:

Small pinch of sugar from each bag.

A. Fries, Pioneer Mill Co.:

A sample is taken from about 40 to 50 bags every strike as soon as they are filled.

A. Krafft, Oahu Sugar Co.:

Every fifth bag sampled.

Geo. F. Renton, Jr., Ewa Plantation Co.:

Through a small slit in the bottom of the grasshopper conveyor.

W. K. Orth, Koloa Sugar Co.:

A pinch of sugar every fifth bag.

A. B. Melancon, McBryde Sugar Co.:

Our sugar is sampled at the scale as the bag is being filled, a pinch being taken for each bag.

There is considerable room for improvement in methods for sampling sugar.

QUESTION 22: What method do you use for conveying bags of sugar, and what are its advantages and disadvantages?

G. Giacometti, Olaa Sugar Co.:

Trucked to railroad cars direct.

H. F. Hadfield, Hilo Sugar Co.:

By means of a conveyor which runs from the sewing machine to the sugar warehouse.

H. D. Beveridge, Onomea Sugar Co.:

Bagged sugar sent from bagging floor to piles in storehouse by gravity flumes. One man piles all sugar from flumes in storeroom, with small breakage.

John J. Muller, Pepeekeo Sugar Co.:

From the bagging floor the bags are sent to the piling floor by chutes.

E. T. Conant, Honomu Sugar Co.:

All done by hand.

K. W. Kinney, Hakalau Plantation Co.:

We use both link and belt conveyors for elevating and conveying sugar bags from scale to cars, and either of them delivers with very little mishap and tearing of the bags.

J. M. Reynolds, Laupahoehoe Sugar Co.:

Bags are loaded directly on the small cars.

E. T. Westly, Paauhau Sugar Plantation Co.:

Chutes and chain conveyors. Advantage: Less manual labor. Disadvantage: A few broken bags.

J. E. Biela, Kohala Sugar Co.:

We use a small truck on which a man takes two bags at a time from the scale and places them in rows in the sugar room for sewing.

R. J. Richmond, Hawi Mill & Plantation Co.:

We use 18″ belt conveyors driven by motor, which take the bags from the sewing machine and deliver to the storage car, where they are piled by one man in tiers of 15 bags on cross pieces fitted loosely on the car, ends projecting. In loading for transportation to station the car is run out onto a central track. A traveling hoist with a beam and depending wire ropes and loops lifts the four tiers containing 60 bags and deposits them on a motor truck, which takes them to the station.

V. Marcallino, Hutchinson Sugar Plantation Co.:

An endless conveyor runs through the sugar room. The bags are first elevated by the conveyor and then dumped into cars

on either side. Only two men handle the sugar after drying. One man bags and weighs; the second man sews the bags.

Joseph Steinberg, Hawaiian Agricultural Co.:

We use a chain conveyor.

J. P. Foster, Maui Agricultural Co.:

We use belt conveyors.

Wm. Searby, Hawaiian Commercial & Sugar Co.:

We use finger-tray elevators and reversible belt conveyors the full length of the sugar room. The advantage of this method is the very small amount of power required. Also, there are no torn bags and we are easily able to unload the bags at any part of the sugar room.

P. W. Alston, Wailuku Sugar Co.:

Link belt chain with small wooden cleats spaced about 20 feet. This is satisfactory.

A. Fries, Pioneer Mill Co.:

Leaving the sewing machine the bags drop on a chute and go directly into the car. Six men for 24 hours.

A. Krafft, Oahu Sugar Co.:

If the sugar is stored, two alternating elevators lift the bags to an endless chain running through the center of the warehouse above the trusses; chutes deliver the bags where wanted. I would prefer a system of portable elevators.

Geo. F. Renton, Jr., Ewa Plantation Co.:

Electric-driven conveyors. No disadvantages.

W. K. Orth, Koloa Sugar Co.:

Our bags are loaded directly into the cars. A small elevator lifts the bags to a chute.

There has been a marked improvement in Hawaii in methods of handling the bags of sugar, during recent years. Statistics covering the last ten years would undoubtedly show considerable decrease in cost in this operation. But little improvement has been made, however, in loading the sugar onto the ships, the Hilo wharf system being a notable exception.

QUESTION 23: Have you a satisfactory method of counting bags shipped or stored? If so, please describe.

H. D. Beveridge, Onomea Sugar Co.:

No satisfactory method of counting sugar delivered to storeroom. Sugar shipped is loaded onto cars from storeroom by hydraulic cranes. Each car contains eight slings, of eight bags per sling, and is delivered to the steamer over a wire rope from cars, in 4-sling lots, or 32 bags. This system is easily checked.

John J. Muller, Pepeekeo Sugar Co.:

An automatic counter is attached to the chute from the bagging floor. This works satisfactorily and gives a good check on all sugars. From the sugar room the sugar is hauled by cars, moved by a one-cylinder 8 h. p. Fairmount motor car. Every car leaving the sugar room is tallied, 50 bags per car. This gives us a check on landing warehouse; from there to steamer 32 bags go per trip. This gives a check on the shipping.

E. T. Conant, Honomu Sugar Co.:

For counting bags stored in sugar room we have an automatic counter located on the chute over which every bag passes. Bags stored in warehouses are tallied by the number of cars hauled each time, each car containing the same number of bags.

K. W. Kinney, Hakalau Plantation Co.:

We use a reciprocating counter attached to the Richardson automatic scale, so that every dump of 124 lbs. of sugar is recorded. The bagging man keeps a count or tally of the number of bags he fills. The stenciler marks the bags by lots of one thousand each, and the man in charge of the department goes over these three different counts at end of each day to get at the number of bags turned out for the day and to see if all three tally.

E. T. Westly, Paauhau Sugar Plantation Co.:

The bags are counted three times before they reach the landing. First, by the bag-marker, who numbers the empty bags in one thousand lots and sends them to the bagging floor in parcels of 50, where they are recounted. After the bags are filled they are shipped to the landing in carloads of 68 each. The last gives us a very good check.

J. E. Biela, Kohala Sugar Co.:

I count the bags as they stand in rows of two on the sugar-room floor.

R. J. Richmond, Hawi Mill & Plantation Co.:

Our only automatic check on the count of bags is the counter on the Richardson scale. Also, as we always put 60 bags on a car, we keep pretty accurate tab on the bags.

V. Marcallino, Hutchinson Sugar Plantation Co.:

Bags are piled in cars, a definite number to a car.

Joseph Steinberg, Hawaiian Agricultural Co.:

We count our bags by the layers on the cars and check by the warehouseman.

J. P. Foster, Maui Agricultural Co.:

Yes. Sugar is shipped on flat cars carrying either 200 or 250 bags. They are checked and rechecked from the warehouse, and again checked at destination. Sugar for storage is bagged in lots of 1000. The empty bags are very carefully counted, and the number filled is known by the number of empty bags on hand.

Wm. Searby, Hawaiian Commercial & Sugar Co.:

We use two counters on each elevator, so that each bag is counted twice. We have never lost count by this method.

P. W. Alston, Wailuku Sugar Co.:

Two automatic counters—one on the automatic scale and one on the bag elevator. Besides this, the men bagging sugar check the bags as used.

A. Fries, Pioneer Mill Co.:

Two Ashcroft counters—one attached to the weighing machine and one at the chute to the cars. They have given no trouble whatever and record accurately the sugar for each car and the total sugar made.

A. Krafft, Oahu Sugar Co.:

Sugar is shipped in box cars, to which it is delivered in 5-bag truckloads. It is stowed in regular piles to a requisite number. Errors are rare. If the sugar is stored the bags are piled in regular tiers, which are counted.

Geo. F. Renton, Jr., Ewa Plantation Co.:

Have as yet found no completely satisfactory and foolproof method.

W. K. Orth, Koloa Sugar Co.:

The cars are always filled in the same manner as to number of bags in a row, and it is easy to see if there is a bag short or over. Also, it is easy to check by weighing loaded cars. When storing we pile in layers of 5 or 10, which are easily counted; I have found mechanical counters unreliable, as broken bags thrown out after being counted are often not deducted.

QUESTION 24: What have you found are the essential points to be observed in piling bags in storage?

G. Giacometti, Olaa Sugar Co.:

Sugar to be cooled. Pile as high as possible to reduce exposed surface; not over 35 bags high.

H. F. Hadfield, Hilo Sugar Co.:

It is important that the bags be not laid lengthwise from bottom to top without cross-layers, as the pile is liable to split open lengthwise.

H. D. Beveridge, Onomea Sugar Co.:

(a) Sugar well dried or below 1% moisture.

(b) Watertight, airtight storeroom with wooden floor kept clean.

(c) Store sugar in large blocks, not over 35 bags high, with the minimum amount of surface exposed to draughts.

(d) Don't keep too long.

John J. Muller, Pepeekeo Sugar Co.:

When piling bags it is essential that the bottom tier as well as all others be piled as closely together as possible. It is also advisable to put the sewed end on the inside, as the pressure otherwise is liable to tear the seam.

J. P. Foster, Maui Agricultural Co.:

Pile so as to avoid the falling of the stack, and provide for easily breaking it down for shipment.

P. W. Alston, Wailuku Sugar Co.:

Sugar should not be bagged and piled while hot. This causes caking of the sugar in the bag, which causes them to break when handled in shipping. Do not pile higher than necessary. The outside of the pile should have header courses to keep the pile from falling, but the insids bags should be laid parallel in order to facilitate handling and reduce losses from breaking when shipping. Do not pile hot sugar on the floor. Do not lay sugar against a new concrete wall or floor.

A. Krafft, Oahu Sugar Co.:

The piles should always be straight and regular, and should be kept at some distance from walls, trusses and columns.

Geo. F. Renton, Jr., Ewa Plantation Co.:

Firm, dry foundation. Interlocking bags on outside edges to prevent them from falling.

W. K. Orth, Koloa Sugar Co.:

A solid level floor, careful placing of first layer, alternating directions of bags so that they bind each other, keeping straight lines and keeping out damaged bags.

QUESTION 25: Give experience, if any, with elevating bags by portable hoists?

K. W. Kinney, Hakalau Plantation Co.:

A portable elevator is an efficient and labor and expense-saving machine for stacking bags of sugar in the warehouse.

Joseph Steinberg, Hawaiian Agricultural Co.:

I consider the portable hoist a handy device for piling bags of sugar.

J. P. Foster, Maui Agricultural Co.:

We used Brown portable hoists some years ago with excellent results, but discarded them in favor of stationary conveying system. The portable machines are better than hand work, but can be improved upon by conveying system.

Wm. Searby, Hawaiian Commercial & Sugar Co.:

Our experience with portable hoists was not entirely satisfac-

tory, as a good many torn bags resulted. We discontinued their use ten years ago.

A. Fries, Pioneer Mill Co.:

Saving of labor.

A. Krafft, Oahu Sugar Co.:

I have found the portable elevator to be a most efficient sugar-handling outfit.

Geo. F. Renton, Jr., Ewa Plantation Co.:

Electric-driven portable hoist is a labor-saving device, delivering sugar to any part of a warehouse and to any height, according to machine, and is just as valuable loading cars from a warehouse as filling warehouse from a car.

QUESTION 26: How many bags high have you found it possible to pile sugar without danger of breaking the bottom bags?

G. Giacometti, Olaa Sugar Co.:

We do not pile more than 32 to 35 bags high, except in an emergency.

H. F. Hadfield, Hilo Sugar Co.:

I have piled to 48 bags high or 3 tons pressure without breaking the bottom bags.

H. D. Beveridge, Onomea Sugar Co.:

30 to 35 bags the limit.

John J. Muller, Pepeekeo Sugar Co.:

We have piled sugar 35 bags high without any damage to the bottom bags.

E. T. Conant, Honomu Sugar Co.:

A good deal depends on the sugar, caked sugar being very difficult to pile. Sugar that is not caked can be piled 30 to 40 high without danger of breaking the bottom bags.

K. W. Kinney, Hakalau Plantation Co.:

The highest sugar piling I have seen is 32 bags high. The bags of the first layer remained intact.

E. T. Westly, Paauhau Sugar Plantation Co.:

Never had occasion to pile higher than 30 bags.

J. E. Biela, Kohala Sugar Co.:

Twenty-five bags high is about the limit which I would recommend, when storing sugar for long periods.

R. J. Richmond, Hawi Mill & Plantation Co.:

Have never had actual experience as to the extreme limit of height for safe piling, but have seen raw sugar stored in refinery warehouses 50 to 60 bags high for long periods without breaking the bottom bags.

V. Marcallino, Hutchinson Sugar Plantation Co.:

Sugar is not piled more than 20 bags high here, so there is little danger of breaking the bottom bags.

Joseph Steinberg, Hawaiian Agricultural Co.:

I find it possible to pile commercial sugar as high as 25 bags.

J. P. Foster, Maui Agricultural Co.:

We have frequently piled 38 high and have had no breakage. Do not know how much higher they could be piled.

Wm. Searby, Hawaiian Commercial & Sugar Co.:

Forty-five.

P. W. Alston, Wailuku Sugar Co.:

Depends on how full the bags are. If too full the bags break under the strain of high piling. About 30 bags high.

A. Fries, Pioneer Mill Co.:

Forty-five high, no broken bags.

A. Krafft, Oahu Sugar Co.:

Forty bags high.

Geo. F. Renton, Jr., Ewa Plantation Co.:

Forty-five to fifty bags high.

W. K. Orth, Koloa Sugar Co.:

I have seen as many as 40 jute bags high stored without breaking the bottom bags. Cotton bags, I have seen 20 high.

This question was discussed at the last meeting, but the information brought out was not satisfactory. The above replies show that forty bags high, at least, is safe.

QUESTION 27: Give the causes and remedies which you have found for the caking of sugar in the bags during storage.

G. Giacometti, Olaa Sugar Co.:

Sugar will not cake if cooled before bagging.

H. F. Hadfield, Hilo Sugar Co.:

Bagging hot damp sugar and piling it without allowing it to cool will cause sugar to cake.

H. D. Beveridge, Onomea Sugar Co.:

Some small-grained sugars, bagged hot, are liable to cake in bags.

John J. Muller, Pepeekeo Sugar Co.:

Good drying is essential. In storage sugar will cake, but this does not do any damage.

E. T. Conant, Honomu Sugar Co.:

Sugar will cake in the bags if it is packed while still hot. This could be remedied by either passing it through a Hersey dryer (without steam) or by storing it in a large bin.

Sugar dried and bagged from hot massecuite heavily charged with first molasses and stored directly will cake hard. Sugar dried from cooled-off massecuites or bagged after cooling in bins generally don't cake.

E. T. Westly, Paauhau Sugar Plantation Co.:

Sugar bagged with too high moisture and stored in a hot place will cake.

J. E. Biela, Kohala Sugar Co.:

(a) Sugars boiled at high temperatures and under low vacuum cake more than sugars from massecuites boiled and discharged under low temperature and high vacuum.

(b) Sugars from low-purity juice into which too much molasses has been returned; in fact, any sugar which does not dry freely and is bagged direct from the centrifugals. To prevent entirely the caking of sugar in storage, the following points would have to be observed:

Discharge strikes at low temperature and high vacuum.

Boil high polarization sugar, i. e., do not draw molasses back into strikes, which means lower recovery of first product and higher loss in final molasses, both of which are prohibitive under present conditions and the marketing arrangements.

To prevent sugars of low polarization from caking in storage there are two inexpensive ways by which this may be accomplished—(a) Dry them in the centrifugals to the lowest possible water content; (b) by passing a current of cold air into the sugar bin or any other receptacle where the sugar passes from the centrifugals. Another way by which the desired result will be more completely accomplished is to keep the sugar in an open pile for as long a period as is required for the heat to escape, but here also enters the question of extra expense which should be avoided.

V. Marcallino, Hutchinson Sugar Plantation Co.:

I believe caking is caused by moist sugar being pressed together.

Joseph Steinberg, Hawaiian Agricultural Co.:

A high per cent of moisture in the sugar and storage in a damp place will cause the sugar to cake.

J. P. Foster, Maui Agricultural Co.:

It is generally due to the sugar being bagged hot, and can usually be prevented by cooling the sugar before bagging. It may also be due to the viscosity of the sugar, and may be sometimes overcome by reducing the lime.

Wm. Searby, Hawaiian Commercial & Sugar Co.:

Using wash water or steam in the centrifugal machines and bagging the sugar hot will cause it to cake in the bag during storage. We do not wash the sugar and we cool it thoroughly before bagging and never have any trouble from the sugar cak-

ing, even though it is piled 45 bags high and left in storage for five or six months.

P. W. Alston, Wailuku Sugar Co.:

Caused by bagging hot. Remedied by cooling before bagging.

A. Fries, Pioneer Mill Co.:

No caking of sugar here.

A. Krafft, Oahu Sugar Co.:

If the sugar is bagged too hot, it will cake if stored immediately.

Geo. F. Renton, Jr., Ewa Plantation Co.:

A sugar that is not sticky with molasses or of low moisture content and bagged *not too hot,* will not cake in storage.

W. K. Orth, Koloa Sugar Co.:

Sugar should be dried as well as possible, especially when it is washed.

The replies are nearly unanimous that the principal cause of caking is bagging the sugar while still hot.

QUESTION 28: What have you found to be the causes for and the best means of prevention of the "sweating" of bags of sugar in storage?

G. Giacometti, Olaa Sugar Co.:

The cause in 98 cases out of 100 is high moisture in the atmosphere. The best prevention is well-closed warehouse with no ventilation.

H. F. Hadfield, Hilo Sugar Co.:

If a bag of hot sugar is placed upon a cold floor, the moisture in the sugar condenses towards the cold side and causes it to sweat. Exposure of a bag of hot sugar to a cold cement wall will also cause it to sweat.

Sugar should always be piled in a cold state upon a dry floor. It takes several years for a new cement floor to dry out, and in order that sugar will keep, boards should be laid over the cement.

H. D. Beveridge, Onomea Sugar Co.:

So-called sweated sugars, in my opinion, are either improperly dried or poorly warehoused, or, as is almost unavoidable on this side of this island, have stood in contact with moisture-laden air. If these causes were removed, I believe our sweated sugar would almost disappear.

John J. Muller, Pepeekeo Sugar Co.:

To prevent sweating, sugar must be well dried, and kept dry in storage.

E. T. Conant, Honomu Sugar Co.:

The only absolute cure for sweating that I know of is speedy shipment. Methods of manufacture have a lot to do with it, but sugar will sweat in spite of all precautions.

K. W. Kinney, Hakalau Plantation Co.:

Any sugar, particularly molasses congealed raw sugar, containing 1¼% or more moisture, becomes an easy prey to sweating if left exposed to a draft of moist air. Therefore, care should be taken not to leave piles too much exposed where humidity is high. Dry bagasse spread to a depth of 3 inches over any kind of floor is a very efficient medium for preventing the sweating of the bottom-layer bags.

J. M. Reynolds, Laupahoehoe Sugar Co.:

A careful protection against moisture, which we believe causes the sweating.

E. T. Westly, Paauhau Sugar Co.:

Caused by moist air. Prevented by eliminating it.

J. E. Biela, Kohala Sugar Co.:

Insufficient drying of sugar and unfavorable location of warehouse.

R. J. Richmond, Hawi Mill & Plantation Co.:

I think that with the comparatively dry and hot conditions of climate at our shipping port, Mahukona, the cause of any sweating that occurs lies in the sugar itself and may be prevented by reducing the moisture present to a safe percentage, the boiling

of a better, harder grain of sugar, and keeping the boiling-house in a sanitary condition.

V. Marcallino, Hutchinson Sugar Plantation Co.:

Sweating is probably caused by moisture either absorbed or left in the sugar on drying.

Joseph Steinberg, Hawaiian Agricultural Co.:

Warm moist sugar when bagged and stored will cause sweating.

J. P. Foster, Maui Agricultural Co.:

We have never had "sweating" of sugar except when sugar is piled over a crack in the floors, or an opening in the sides, as a crack, a door, or a window. It is clearly due, in our warehouse, to absorbed external moisture.

Wm. Searby, Hawaiian Commercial & Sugar Co.:

Using wash water in the centrifugal machines or allowing the dilution indicator to get too high will result in sweating of the bags in storage. The best means to prevent sweating is to keep the dilution indicator at a safe point, cool the sugar off before bagging, and keep it in a clean, airtight warehouse.

P. W. Alston, Wailuku Sugar Co.:

Hot bags piled on a cold cement floor. Sugar piled on a new concrete floor not thoroughly dried out. The outside bags of a pile that are exposed to moist air. In moist climates the room should be damp-proof. In a dry climate air circulation will do no harm.

A. Fries, Pioneer Mill Co.:

Causes: Too much moisture in the sugar and bagged while hot.

A. Krafft, Oahu Sugar Co.:

Fresh concrete floors cause sweating of sugar; also excessive washing in the centrifugals, the use of contaminated water and uncleanliness in any stage of manufacture.

Geo. F. Renton, Jr., Ewa Plantation Co.:

Causes: High moisture content of sugar and unsanitary condition around sugar room and centrifugals. Prevention: Eliminate above objections; keep the warehouse floor clean and dry.

W. K. Orth, Koloa Sugar Co.:

Dry well, use clean water for washing, be careful that no massecuite drops into the dry sugar. Do not store before the sugar is cooled. Our experience is that all sugar dried during the night and stored during the day keeps better than sugar dried during the day and stored right away, because it is cooled when stored. I believe that the smaller bags used in Hawaii are one cause of our sugars keeping better than Cuban sugars. Sweating starts from the hot center of the bag and progresses outward. Sugar in smaller bags cools more rapidly.

There was no new information brought out in reply to Question 29: "Have you had any new experience in the causes or methods of prevention of deterioration of sugars?"

In addition to replies to the questions, Mr. Westly of Paauhau adds the following:

Stopping waste and trying to economize on every hand is and should be the watchword under present war-time conditions. In that connection I would like to ask, "Would not the making and shipping of a sugar of a higher polarization, say over 98, be a step in the right direction?" It would mean a saving in bags, twine, storage, ship space and handling. It should also cut down the deterioration of sugars. The above are only a few of the advantages. The refiners would benefit greatly by it, as their capacity would be increased and less bone char would be required, to say nothing of numerous other benefits they would have.

The manufacturing of a 98 pol. sugar should not offer any difficulties; rather, the opposite. I fully realize the disadvantage in selling a 98 pol. sugar from a dollar-and-cent point of view.

At the same time, I do not think it would be so very big if everything was taken into consideration. The total Hawaiian crop of 1917 was 644,574 tons, and assuming the polarization to be 96.50, we get 622,014 tons of sucrose shipped. If that amount of sucrose had been shipped in the form of 98 pol. sugar, we get 634,708 tons of sugar, or 9866 tons less. With 124 lbs. of sugar per bag it would mean a saving of 159,129 bags. The loss in transit would be correspondingly less, without taking into consideration the better keeping of a higher polarizing sugar.

A MODERN CUBAN FACTORY.*

The following description of a lately built factory of Eastern Cuba, is given as indicating modern tendencies in construction and ideas as to equipment of some of the best known organizations. Juice extractions of about 83 have been obtained at this factory with average imbibition. The full, real capacity of the factory can hardly be given in hard and fast figures. Every sugar expert will understand that the actual capacity of a factory does not only depend on cane crushed per day, but also on water evaporated, and on sugar boiled and treated. Twelve per 100 of sucrose entering process means for the boiling house a task by 20 per cent greater than 10 per cent of sucrose entering process, for one and the same tonnage crushed.

The principal equipment consists of the following:

A complete milling plant including one 32x78-inch two roller crusher, and five 34x78 inch three roller mills; driven by one 34x60-inch and one 30x60-inch Corliss engine. With all necessary gearings, hydraulics and carriers.

One set of juice scales (two of 1000 gallons) with recording beams.

Three juice heaters of 1000 sq. ft. heating surface each.

Ten defecators, of 5560 gallons each.

Ten scum tanks of 2660 gallons each.

Three liming tanks in all 16,050 gallons.

Eight filter-presses 36-in. square, side feed, of 54 chambers each.

One quadruple effect evaporator, standard, 17,000 sq. ft.

One pre-evaporator 4000 sq. ft.

Two 12-ft. vacuum pans, 1200 cu. ft. capacity each.

One 12-ft. coil vacuum pan 1200 cu. ft. capacity.

Fifteen crystallizers 8 ft. 10 in. x 23 ft. 3½ in. long each.

Sixteen 40-in. belt driven centrifugals with two steel mixers.

Nine boilers 90 in. x 20 ft.

Nine Foster superheaters for nine boilers.

Four cast-iron counter-current condensers with 36 ft. leg pipe.

Spray pond, consisting of 240 spray nozzles, 48 cast iron spray heads, 192 bent spray arms, 48 straight spray arms, together with pipes, valves and fittings.

Turbo-generators and motors including 2-645 K.W., 480 volts, 3 phase, 60 cycle turbo-generators; 1-50 K.W., 480 volts, 3 phase, 60 cycle turbo generator; 50 motors for pumps.

Four standard LeBlanc air pumps

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* Sugar, October, 1918.

One soda tank; 1 hot clear juice tank; 1 water-service tank; 9 pan storage tanks; 2 eliminators; 1 air receiver; 1 scale hopper tank; 1 hot molasses tank; 1 mud tank; 2 lime tanks; 1 evaporator sweet water tank; 2 molasses floor tanks; 1 return trap water tank.

Pumps—One packed piston type, 250,000 gals. per 24 hours; 1 8x12-in. geared magma pump; 1 16x10½x18-in. boiler feed simplex pump; 2 7x8-in. single acting Triplex pumps; 3 more idem; 2 4-in. horizontal type D volute centrifugal pumps; 2 5-in. horizontal type S turbine centrifugal pumps; 2 4-in. horizontal type D volute centrifugal pumps; 2 3-in. horizontal type S turbine centrifugal pumps; 2 15-in. horizontal pumps 5000 gals. per minute capacity, for 70-ft. head; 2 idem for 30-foot head; 1 4-in. horizontal pump 100 gals. capacity per minute against 150-ft. head; 2 centrifugal pumps capacity 70 gals. per minute against 75-ft. head; 8 Cameron volute pumps of 3-in. and 2-in.

One portable elevator for piling sugar bags.

One 42-in. diameter x 54-in. long cloth washer, brass cylinder.

One hydro-extractor.

One 60-ton iron frame track scales.

One sugar test scales.

One 8x8-in. Ingersoll-Rand air compressor..

One sugar bagging scales.

Massecuite screw conveyor, and sugar screw conveyor and elevator.

One whitewashing machine.

One Swartwout cast-iron oil separator..

Steel buildings, with an estimated weight of structural steel of 793 tons.

One machine shop including a 5-ft. Universal radial drill; a 36-in. x 36 in. x 8-ft. planer; a 30-in. x 20-in. x 6 in. engine lathe; a No. 4 milling machine; a No. 1 hacksaw; a No. 5 grinding machine; grindstone; reamer and grinder; a 4-in. pipe threading machine; a 12-in. idem; a 1½-in. bolt threading machine; a 16-in. x 8-ft. engine lathe; a 24-in. Aurora drill; two steel blacksmith forges; one pressure blower; a 24-in. shaper; a No. 8 champion power hammer.

One steel stand pipe 15-ft. diameter x 75-ft. high.

One tank for final molasses 63-ft. x 30-ft. high.

One Pietch automatic cane feeder.

One 20-ton hand power traveling crane. One 5-ton idem.

One radial brick chimney 185 ft. high, 10 ft. in diameter.

One 80 h.p. locomotive boiler complete with 60-ft. steel stack..

Four steel towers.

1 2½ Venturi-meter outfit. [R. S. N.]